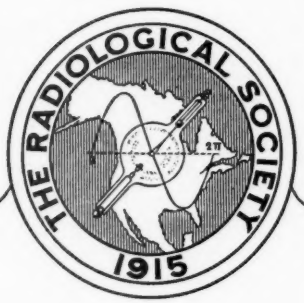
Med V

CIRCULATING ISSUE

FORTY-SEVENTH ANNUAL MEETING, PALMER HOUSE, CHICAGO
NOVEMBER 26–DECEMBER 1, 1961

RADIOLOGY

A MONTHLY JOURNAL DEVOTED
TO CLINICAL RADIOLOGY AND
ALLIED SCIENCES



DARTMOUTH COLLEGE
APR 4 1961
LIBRARY

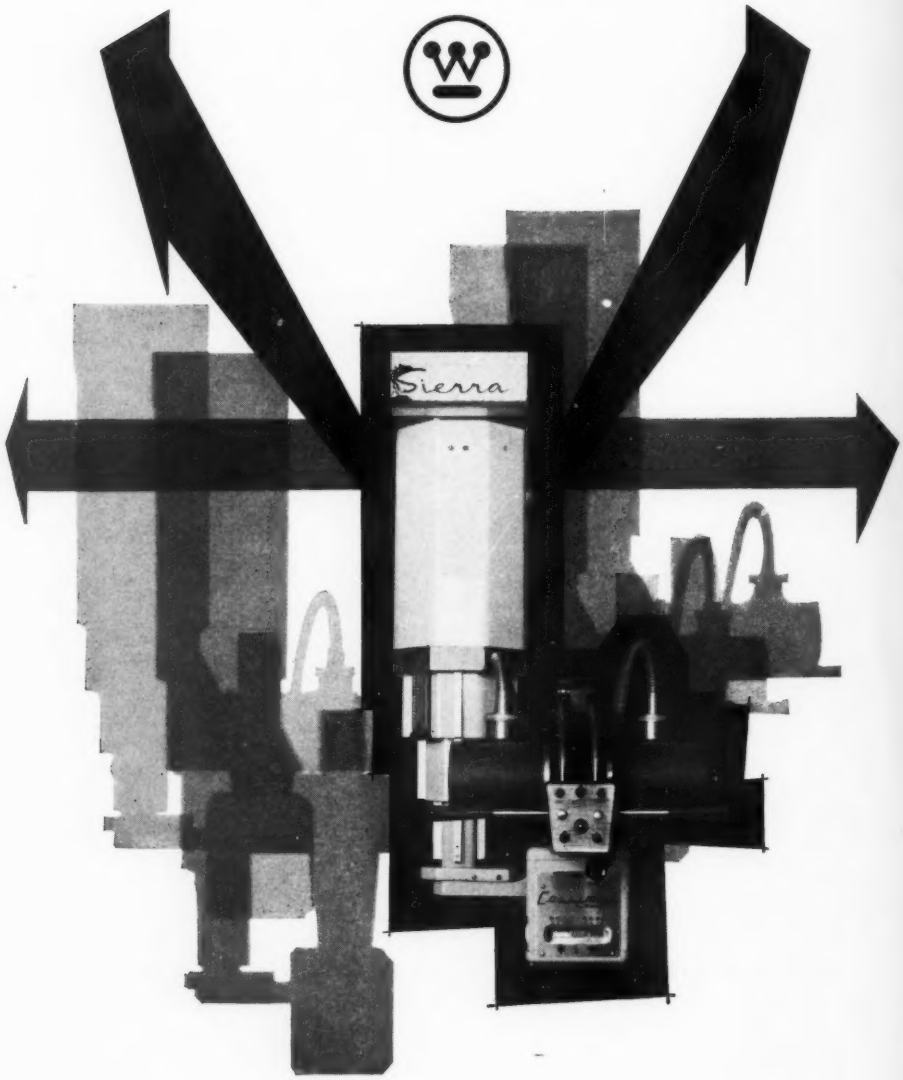
MARCH · 1961

VOLUME 76 NUMBER 3

Owned and Published as its Official Journal by
THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

The new Sierra achieves the maximum in stability and in flexibility
This Westinghouse overhead tubesupport operates with minimum effort, throughout the room. The Sierra's rigid telescoping column is synchronized and weight-balanced. Permits 54 inches of vertical travel. Accepts all standard tubeheads. Takes optional accessories. Locks electrically. For more information: Westinghouse Electric Corporation, X-Ray Department, 2519 Wilkens Avenue, Baltimore 3, Maryland. You can be sure . . . if it's **Westinghouse**

J-08391



RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

Vol. 76 MARCH 1961 No. 3

CONTENTS

INTRODUCTION OF CARMAN LECTURER AND GOLD MEDALIST: WARREN H. COLE, M.D. *Theodore J. Wachowski, M.D.* 351

HISTORICAL FEATURES OF CHOLECYSTOGRAPHY. THE CARMAN LECTURE. *Warren H. Cole, M.D.* 354

THE IMPORTANCE OF CERVICAL MYELOGRAPHY IN CERVICAL AND UPPER THORACIC NERVE ROOT AVULSION. *William Joseph Varley, M.D.* 376

SPINAL CORD TUMORS. *G. Lombardi, M.D., and A. Passerini, M.D.* 381

LEFT RETROGRADE CARDIOANGIOGRAPHY: ITS DIAGNOSTIC VALUE IN ACQUIRED AND CONGENITAL HEART DISEASE. *Kurt Amplatz, M.D., Richard G. Lester, M.D., Richard Ernst, M.D., and C. Walton Lillehei, M.D.* 393

THE RENAL ARTERIES. AN EVALUATION OF ROENTGEN METHODS OF OPACIFICATION. *Samuel D. Hemley, M.D., Edward J. Arida, M.D., and Edward M. Ring, M.D.* 402

NON-STRANGULATING DISTAL ILEAL OBSTRUCTION. PART I: THE ROLE OF HYDRATION. AN EXPERIMENTAL STUDY CORRELATING PATHOLOGIC AND RADIOLOGIC FINDINGS. *Robert D. Sloan, M.D., Joseph W. Brock, M.D., and William M. Fant, M.D.* 407

ROENTGEN EXAMINATION OF THE CECUM AND PROXIMAL ASCENDING COLON WITH INGESTED BARIUM. *E. Robert Heitzman, M.D., and Alfred S. Berne, M.D.* 415

PALLIATION OF OSSEOUS METASTASES FROM BREAST CARCINOMA WITH RADIOACTIVE PHOSPHORUS ALONE AND IN COMBINATION WITH ADRENALECTOMY. *John P. Storaasli, M.D., Richard L. King, M.D., Harvey Krieger, M.D., William E. Abbott, M.D., and Hymer L. Friedell, M.D.* 422

AFTERLOADING TECHNIC WITH RIGID NEEDLES IN INTERSTITIAL RADIATION THERAPY. *Herman D. Suit, M.D., Robert J. Shalek, Ph.D., E. B. Moore, B.S., and J. Robert Andrews, M.D.* 431

TECHNICAL CONSIDERATIONS IN SCINTILLATION SCANNING OF THE HUMAN SPLEEN. *Philip M. Johnson, M.D., and John C. Herion, M.D.* 438

CONGENITAL GENERALIZED FIBROMATOSIS. CASE REPORT, WITH ROENTGEN MANIFESTATIONS. *Virgil R. Condon, M.D., and R. Parker Allen, M.D.* 444

LYMPHANGIOMA OF BONE. *Charles E. Shopfner, M.D., and R. Parker Allen, M.D.* 449

FETAL TOLERANCE TO RADIATION. A CASE REPORT. *Alvaro Ronderos, M.D.* 454

OSTEOGENESIS IN MULTIPLE MYELOMA. REPORT OF A CASE. *Edward C. Porter, M.D.* 457

DOSE TO THE EYE FROM RADIOGRAPHIC PROCEDURES. *Elizabeth F. Focht, B.A., George R. Merriam, Jr., M.D., Mary Barnes, A.B., and John A. Evans, M.D.* 459

EXPERIMENTAL COMPARISON OF ORTHO-IODOHIPPURIC ACID AND IODOPYRACET IN RENAL FUNCTION EVALUATION. *Joseph E. Whitley, M.D., Richard L. Witcofski, M.S., and I. Meschan, M.D.* 464

(*continued on page iv*)

RADIOLOGY

A MONTHLY PUBLICATION DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

PUBLISHED BY THE RADIOLOGICAL SOCIETY OF NORTH AMERICA, INC.

EDITOR

HOWARD P. DOUB, M.D.
Henry Ford Hospital, Detroit 2, Mich.

ASSOCIATE EDITORS

Leo G. Rigler, M.D.
Laurence L. Robbins, M.D.
Harold W. Jacox, M.D.
William R. Eyler, M.D.

EDITORIAL ASSISTANTS

Marion B. Crowell, A.B.
Florence Roper Jeffery, A.B.
Arlene W. Hipple, A.B.

ADVISORY EDITORIAL BOARD

Richard H. Chamberlain, M.D.
Edith H. Quimby, Sc.D.
Arthur Purdy Stout, M.D.
Donald S. Childs, Jr., M.D.
Robert P. Barden, M.D.

PUBLICATION COMMITTEE

John A. Evans, M.D., Chairman
William T. Moss, M.D.
John L. McClenahan, M.D.

Published monthly by The Radiological Society of North America, Inc., at 20th and Northampton Sts., Easton, Pa. Second class mail privileges authorized at Syracuse, N. Y., with additional entry at Easton, Pa. Acceptance for mailing at a special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized November 24, 1934.

Subscription rate $15.00 per annum. Canadian postage. $1.00 additional. Foreign postage, $2.50 additional. Single copies $2.50 each. Remittance for non-member subscriptions should be made payable to The Radiological Society of North America, Inc., and should be addressed to the BUSINESS MANAGER, RADIOLOGY, 713 E. GENESEE STREET, SYRACUSE 2, NEW YORK, as should all correspondence relative to business matters connected with The Radiological Society of North America and RADIOLOGY. In requesting change of address, both the old and the new address should be given.

Dues to The Radiological Society of North America include subscription to RADIOLOGY and should be paid to Dwight V. Needham, M.D., TREASURER of The Radiological Society of North America, Inc., 713 E. GENESEE STREET, SYRACUSE 2, NEW YORK.

Inquiries regarding the program for the Annual Meeting of the Society for the current year should be sent to the President.

Contents of RADIOLOGY copyrighted 1961 by The Radiological Society of North America, Inc.

CONTENTS *(continued from previous page)*

AN AUTOMATIC DEVICE FOR VOIDING URETHROGRAPHY IN INFANTS AND SMALL CHILDREN. *J. Scott Dunbar, M.D., F.R.C.P. (C) Richard B. Goldbloom, M.D., F.R.C.P. (C), Victor Pollock, and Rex Radford, S.R.N., M.S.R. (R).* 467

A SPECIAL AXIAL ROTATION TABLE FOR PNEUMOENCEPHALOGRAPHY. *Juan M. Taveras, M.D.* 472

EQUIPMENT AIDS IN INTRAVENOUS PYELOGRAPHY. *W. C. Smullen, M.D., J. W. Little, Jr., M.D., and F. A. Winters, M.D.* 475

WORK IN PROGRESS.

ABSORBED DOSE IN THE THORACIC VERTEBRAE IN CHEST ROENTGENOGRAPHY. *R. Wilson, B.Sc., and J. A. Carruthers, Ph.D.* 478

SOLID-STATE AND PROPORTIONAL BETA DETECTORS FOR USE IN VIVO. *C. V. Robinson, Ph.D.* 479

EDITORIAL: SOME LOGISTICS OF THE RADIOLOGICAL SOCIETY OF NORTH AMERICA, WITH THOUGHTS ABOUT THE FUTURE. *Theodore J. Wachowski, M.D.* 480

IN MEMORIAM: CHARLES HUNTER HEACOCK, M.D. 484

JOHN EVANS HEATLEY, M.D. 485

ANNOUNCEMENTS AND BOOK REVIEWS 486

ABSTRACTS OF CURRENT LITERATURE 490

RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

PUBLISHED BY THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

Vol. 76 MARCH 1961 No. 3

Introduction of Carman Lecturer and Gold Medalist Warren H. Cole, M.D.

THEODORE I. WACHOWSKI, M.D.

THIS EVENING we again are gathered to honor the memory of Dr. Russell D. Carman, who in 1923 was the eighth President of The Radiological Society of North America. The Carman Lecturer tonight is Dr. Warren H. Cole, Professor of Surgery at the College of Medicine, University of Illinois, Chicago.

Both Dr. Carman and Dr. Cole had their early medical experiences in St. Louis. Dr. Cole had done the spade work in the investigation which resulted in the first radiographic visualization of the functioning gallbladder. For many years this was known as the Graham-Cole test. Dr. Carman was intensely interested in the new test and soon after its announcement went to St. Louis, from his new post at the Mayo Clinic, to learn more about it.

Dr. Cole has been one of my idols, as a clinician and as a teacher, since 1936, when he assumed his post at the University of Illinois.

Dr. Cole was born in Clay Center, Kans. He took his B.S. degree at the University of Kansas and his M.D. degree at Washington University School of Medicine in St. Louis. His internship was at City Hospital, Baltimore, and his surgical training at Barnes Hospital in St. Louis, from 1921 to 1926.

It was during this time that Dr. Cole, together with Dr. Evarts Graham, Dr. T. Copher, and Dr. Sherwood Moore, did the investigative work which resulted in the x-ray visualization of the concentrating gallbladder. For it he and his co-workers received the Leonard Research Prize of the American Roentgen Ray Society in 1926. This was only the beginning of a brilliant career.

From 1926 to 1936 Dr. Cole was associated with the Department of Surgery of Washington University in St. Louis, rising to the rank of Associate Professor. In 1936 he went to the University of Illinois as Professor and Head of the Department of Surgery where, I am happy to say, he has remained.

My impression is that inherently Dr. Cole must have been shy. I base this impression on my first meeting with him. It was 1936, and the University of Illinois was seeking a Head for the Department of Surgery. Dr. Adolph Hartung, my preceptor, was interpreting films in a small office which was separated from a waiting room by a Dutch door, the top half of which was open. I was there listening, learning (I trust), and ready to do odd jobs.

A man of medium build came to the waiting room, looked in the door, and stated that he was a surgeon and was visiting the Medical College and the hospital. With that entree, Dr. Hartung began to express his ideas of the needs of the Surgical Department. He felt

WARREN H. COLE, M.D.

Carman Lecturer

strongly that the faculty should try to attract somebody really good to head the Surgical Department, "somebody like that fellow Cole in St. Louis." Dr. Hartung stopped to light his ever-present pipe. While he was doing so, the visitor made some vague remark and departed quickly. Later we learned that he was Dr. Warren H. Cole.

He must have outgrown this shyness because in his *curriculum vitae*, which is far too long to give in detail, I count eleven organizations of which he has been President. These include the American Surgical Association, the American College of Surgeons, the American Board of Surgery, the American Goiter Association, the Chicago Medical Society, the Society of University Surgeons, and the American Cancer Society, of which he is the immediate Past President. He also has served other organizations in lesser capacities, and is on the advisory committees of several institutions and of the United States Public Health Service.

Dr. Cole's research activities, both basic and clinical, have resulted in over 270 articles on various subjects, mainly surgery and, lately, cancer and its control. He is co-author of three textbooks and editor of a two-volume work on *Operative Technique*. He is on the editorial boards of four surgical journals, of two "systems" of surgery, and of one medical publishing company.

Dr. Cole's talents have not been overlooked by his colleagues. He has been elected an honorary member of ten local surgical societies outside his home state and also of the British Columbia Surgical Society, the Argentine Surgical Association, and the Horse Shoe Club in London, England. He has been called to act as Visiting Professor of Surgery at Ohio University; University of Cincinnati; University of Louisville; and Baylor University in this country. He has performed similar services at the University of London Postgraduate School. In 1948 he was sent to England by the United States Foreign Service; that was a scientific mission, not "cloak and dagger" work.

Dr. Cole has been honored by being invited to give many special lectures, such as the Carman Lecture that he is delivering here tonight. For the sake of brevity let me say only that he has delivered nine such lectures in this country, one in London, England, one in Belfast, Ireland, and one in Edinburgh, Scotland.

Now, I am not talking about a man who devotes his entire life to science, although the story is told that he dictated manuscripts until 3:30 p.m. and then left the office hurriedly to make a 4 p.m. wedding (his own), commenting as he left, "I'll have to hurry because I must stop and get the ring." The lady he had on his mind was Clara McFerren, originally of Richmond, Va., and the year was 1942.

I don't know whether Dr. Cole is a member of *Field & Stream's* club called The Lower Forty Shooting, Angling and Inside Straight Club, but I'll bet he could tell you where and how to catch fish on a float trip down the White River in the Ozarks even today. And if you are out for upland game birds, he's your man. The report from a medical student who invited Dr. Cole to the family farm for a pheasant shoot was short: "Two shots, two birds."

Dr. Cole is the sort of man who takes an interest in his trainees. This feeling is reciprocated, and the thirty or so residents he has trained have formed the Warren H. Cole Society "simply to pay him honor." So we, too, would pay him honor. This honor reflects not only his role in the development of the radiographic visualization of the concentrating gallbladder, which I will always think of as the Graham-Cole test, but also his general excellence as physician, scientist, and man.

Historical Features of Cholecystography

The Carman Lecture[1]

WARREN H. COLE, M.D.

ALTHOUGH we may not be fully aware that each discovery in science is dependent upon another of equal importance, we realize this fact when we undertake a study of the development of any significant idea. Since this is true, we often wonder why the author of one discovery does not capitalize on it and proceed with the development of the other which appears to follow so obviously. It is amazing how seldom this progression is made by one man or group of men.

The concept of cholecystography was developed by Evarts Graham and was based upon two previous discoveries. One of these was the demonstration by Abel and Rowntree (1), in 1910 that phenoltetrachlorphthalein was excreted almost entirely in the bile. The other was the demonstration by Rous and McMaster (2), in 1921, that the normal gallbladder was able to concentrate bile eight to ten times by absorbing water (Fig. 1). Abel and Rowntree were searching for a cathartic which could be given by hypodermic injection, hoping also for one which had a prolonged action. They found that phenoltetrachlorphthalein when administered hypodermically, particularly in oil, was non-toxic and would produce a prolonged cathartic effect. They noted that about 90 per cent of this substance was excreted in the bile as the conjugated and free forms (both of which are colorless) and could be demonstrated without chemical analysis by adding a drop or two of alkali to bile collected a few hours after administration of the material. Phenolphthalein itself was found to be excreted primarily by the kidneys. It was found also that phenolsulfonphthalein was excreted partly by the liver but mostly by the kidneys. Rosenthal and White (3)

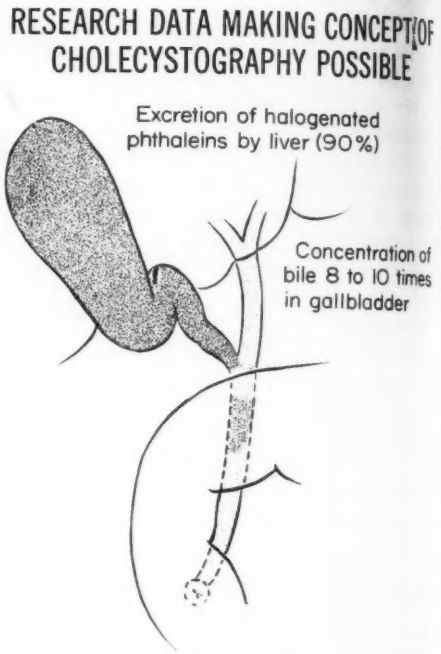

RESEARCH DATA MAKING CONCEPT OF CHOLECYSTOGRAPHY POSSIBLE
Excretion of halogenated phthaleins by liver (90%)
Concentration of bile 8 to 10 times in gallbladder

Fig. 1. The concept of cholecystography was dependent upon two experiments previously performed: (1) the discovery that 90 per cent of halogenated phenolphthaleins were excreted by the liver, and (2) the demonstration that the normal gallbladder could concentrate the bile eight to ten times.

utilized this data later (1925) to develop the Bromsulphalein test for hepatic function, which has survived during the decades and is now recognized as a valuable liver function test.

At a meeting shortly after our discovery of cholecystography, Doctor Graham and I happened to see Doctor Rowntree. We expressed our appreciation for the valuable material he and his associate had presented and asked why they had not carried their experience further for the development of gallbladder visualization. He expressed chagrin and stated that he presumed it was

[1] From the Department of Surgery, University of Illinois College of Medicine, Chicago, Ill. Presented at the Forty-sixth Annual Meeting of the Radiological Society of North America, Cincinnati, Ohio, Dec. 4–9, 1960.

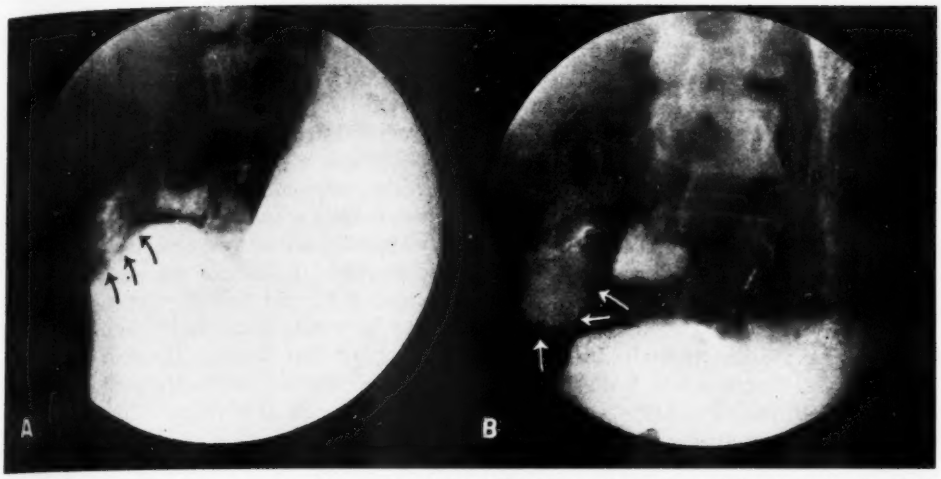


Fig. 2. A. Arrows indicate a supposed impression of the gallbladder on the antrum of the stomach. B. Cholecystogram is indicated by arrows. Normal gallbladder. (Reproduced by permission from Graham, Cole, Copher, and Moore: Diseases of the Gall Bladder and Bile Ducts. Philadelphia, Lea & Febiger, 1928.)

another example of being "too close to the forest to see the trees."

RADIOLOGIC CRITERIA OF GALLBLADDER DISEASE BEFORE CHOLECYSTOGRAPHY

As an introduction to this discussion, it appears appropriate to call attention to the radiologic methods utilized in diagnosing gallbladder disease during the period preceding the development of cholecystography. As at present, opaque (calcium) stones were demonstrable on the plain film, but it was realized that such stones represented a minority of those existing and found at operation. The other mechanisms of diagnosing gallbladder disease were much less accurate. Some are referred to as the indirect method. Adhesions caused by pericholecystitis produced dislocation or immobilization of other organs, which could be demonstrated during the barium-meal examination. In this phase of diagnosis, Lewis Gregory Cole (4) was a pioneer and described deformities of the stomach, duodenum, and colon adjacent to the diseased gallbladder (Fig. 2). A little later A. W. George and R. D. Leonard (5) began emphasizing the production of a shadow (thickened wall) on the plain film by the pathological gallbladder. They maintained a working hypothesis that the normal organ is not visualized on a plain film.

These are only a few of the mechanisms utilized forty years ago by roentgenologists in diagnosing disease of the gallbladder. So common was such disease that discussion of the radiologic technics represented a paramount issue, and unfortunately involved a lot of controversy because the characteristics described as having diagnostic value were so uncertain. All of us realize that these indirect methods were subject to a high percentage of error, but by the arguments to which they gave rise they fostered the exchange of ideas. Some radiologists were so enthusiastic about these indirect methods that they were very loath to accept cholecystography as having any value.

I still have a vivid recollection of numerous occasions when, as a house officer, I would consult Dr. Sherwood Moore, Professor of Radiology in Washington University, concerning interpretation of films demonstrating possible gallbladder disease. Although the diagnosis in a few cases seemed obvious, the findings on the film appeared uncertain to me. Dr. Moore was an astute diagnostician and warned me of the questionable value of many of the indirect methods.

MY CONTACT WITH WALTER MILLS AND RUSSELL CARMAN

I suspect that the majority of radiologists in attendance upon this lecture are not old enough to have known Walter Mills and Russell Carman personally, although all of you know of their work. Walter Mills and Russell Carman were two of the important pioneers in the development of technics and criteria for diagnostic barium studies of the gastrointestinal tract. I, of course, knew Dr. Mills quite well because of my contacts with him in Barnes Hospital, St. Louis, when I was an intern and house officer. Dr. Mills was a serious-minded person who worked incessantly at his job. He was so busy he seldom stopped to talk to us, but I became deeply impressed with his very receptive mind and brilliance as a fluoroscopist. The sharpness of his eye was brought vividly to my attention one day in the viewing room.

After we had obtained our first cholecystogram (in the dog), with negative results for several days thereafter, I went back to the Radiology Department, got the first positive film out again, and looked it over to be certain that we were not misled by some round bone or other object the dog might have swallowed accidentally. We did not make plain films of these animals before administration of the medium and foreign bodies therefore could not be ruled out satisfactorily. As I was standing near the view box studying the film to make sure the shadow was in fact that of a gallbladder, out of the corner of my eye, I saw Doctor Mills come through the door and walk through the viewing room toward an exit. He was wearing his dark glasses and peering staight ahead in his rush to get to the adjacent room. I heard him walking rapidly and then suddenly skid to a stop. "Young fellow," he said, "where did you get that film?" I replied that this was the film of an animal used by Dr. Graham and myself in some experiments attempting to visualize the gallbladder. I stated further that we had obtained this one positive shadow, but had been unable to reproduce it and that I was studying it to rule out a foreign body. To this his reply was: "Don't be silly, young man; this is a shadow of the gallbladder and it is so dense that application of the method to the human being is purely a matter of additional experimentation."

My only contact with Russell Carman was during a visit he paid us shortly after we published our first paper on cholecystography. I had, of course, heard much about him and felt highly complimented that he would come to St. Louis to talk to us about our work. He told us frankly that he wanted to institute the diagnostic procedure in the Mayo Clinic. We explained that we were making our solution of calcium tetrabromphenolphthalein in individual doses, that after its preparation it had to be sterilized, and furthermore it took an hour to give it. I estimated that it took three hours to prepare the solution and to complete the injection into the patient. He looked quite perturbed and said: "That's fine, young man, but how are we going to conduct these injections on 25 patients in one morning?" Although I had heard that the Mayo Clinic was a large institution, I did not realize it was that large, and Dr. Carman must have been amused at my obvious surprise and mild shock when I heard how many patients might be signed up for a gallbladder test on a single day. I told him that we were conducting some experiments with sodium tetraiodophenolphthalein, which was so soluble it could be prepared more rapidly. He seemed much relieved, but I added quickly that up to date the toxicity of the iodine compound was quite inconstant and undependable.

Dr. Carman made no further comment, but he obviously had made up his mind to try the procedure because a short time later he sent Dr. Virgil Counseller down to visit us and learn the technic. I recently had a very pleasant visit with Dr. Counseller (who now lives in Phoenix, Ariz.) over the phone. He told me that, after returning to the Mayo Clinic following his visit with us, he began injecting calcium tetrabromphenolphthalein solution, as we were

doing, and that he might inject as many as 15 to 16 patients per day. I do not know how Dr. Counseller arranged the intravenous injections with the required medical observations, but it speaks well for his organizing ability. Nor do I know whether he was trying to be kind to me when I asked him about reactions, but he stated that they were not troubled with serious reactions, although they had numerous minor ones.

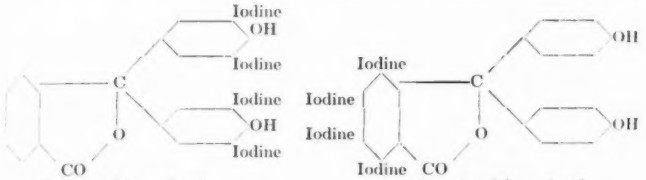


Fig. 3. Structural formulae for the halogenated phthaleins. (Reproduced by permission from Graham, Cole, Copher, and Moore: Diseases of the Gall Bladder and Bile Ducts. Philadelphia, Lea & Febiger, 1928.)

PHARMACOLOGY OF HALOGENATED PHTHALEINS

The halogenated phthaleins (Fig. 3) behave pharmacologically very much as does phenolphthalein itself. Tetrabromphenolphthalein has a molecular weight of 634 and contains about 50.5 per cent bromine by weight. Tetraiodophenolphthalein has a molecular weight of 822 and contains 61 per cent iodine. At the beginning of our experiments, we were aware of the fact that, because of the increased molecular weight, the iodine compound should yield better radiologic shadows than the bromine compound, but our preliminary investigations revealed a greater though inconstant toxicity of the iodine preparation. Later we learned that this toxicity was related to impurities. We also learned that the lethal dose of the various halogenated phthaleins is the same, namely, 0.2 to 0.3 gm. per kilogram of body weight; this was about one-fifth the dose required for clinical use with the iodine compound and about one-third the clinical dose for the bromine compound. When we gave these drugs to our animals, hoping to produce cholecystographic shadows, we naturally used a dose only slightly below the lethal level. On the contrary, when we began their use in human beings, we cut the dose to one-third the lethal dose of the bromine compound in animals and about one-fifth the lethal dose of the iodine compound. We did this to obtain a wide margin of safety, particularly since the inconstant toxicity suggested that some patients might be allergic to the drug. The fact that the toxicity for the various halogenated compounds was about the same indicated rather clearly that the phenolphthalein radical and not the halogen was responsible for the toxic effect.

When we injected the solution rapidly into animals, a fall in blood pressure resulted. In animals lethal and sublethal doses injected intravenously often produced necrosis of the liver, but we did not encounter this effect in any human being from whom we obtained biopsy specimens. Vomiting was common in animals as well as in man. Diarrhea was observed after oral administration in both animals and human beings, but not after intravenous injections.

ANIMAL EXPERIMENTS

Before beginning work on our problem, we consulted the Mallinckrodt Chemical Works, inquiring if they would be interested in supplying several halogenated phthalein compounds to aid us in our efforts to visualize the gallbladder. They expressed a willingness to co-operate and assigned a chemist, Dr. N. Drake, to work with us in the manufacture and procurement of such compounds. It happened

TABLE I: OF 89 DRUGS TESTED EXPERIMENTALLY, THE 13 LISTED BELOW WOULD PRODUCE A SHADOW OF THE GALLBLADDER IN THE DOG OR RABBIT

I. HALOGENATED DERIVATIVES OF PHENOLPHTHALEIN COMPOUNDS
   1. Tetraiodophenolphthalein
   2. Tetrabromphenolphthalein
   3. Octabromphenolphthalein

II. HALOGENATED DERIVATIVES OF ISO-PHENOLPHTHALEIN
   1. Tetraiodo-iso-phenolphthalein

III. HALOGENATED DERIVATIVES OF PHTHALEIN COMPOUNDS
   1. Phenoltetrabromphthalein
   2. Phenoltetraiodophthalein
   3. Tetrabromphenoltetrachlorphthalein
   4. Tetrachlorphenoltetrabromphthalein

IV. SULPHONATED HALOGENATED DERIVATIVES OF PHENOLPHTHALEIN
   1. Phenoltetrabromsulphonphthalein (Bromsulphalein)

V. HALOGENATED DERIVATIVES OF RESORCINOLPHTHALEIN OR FLUORESCEIN
   1. Tetrabromfluorescein (eosin)
   2. Tetraiodofluorescein (erythrosin)
   3. Tetraiodotetrachlorfluorescein (rose bengal)
   4. Octaiodofluorescein

that the first compound we could obtain was phenoltetrachlorphthalein, which we injected into some dogs intravenously to obtain preliminary data on toxicity. We did not expect this compound to produce a shadow of the gallbladder, since the atomic weight of chlorine is 35.5 compared to 80 for bromine and 127 for iodine. Realizing that elements with high atomic weight would cast better x-ray shadows, we planned early in the experiments to obtain strontium and calcium salts of the bromine and iodine compounds. Practically all of the free acids of the halogenated phenolphthalein compounds are insoluble in water, but they become soluble when salts are formed by addition of alkalis.

Accordingly, week after week we tried the sodium salt, calcium salt, and strontium salt of tetrabromphenolphthalein and tetraiodophenolphthalein (see Table I). I made the solutions by the addition of sodium hydroxide, calcium hydroxide, and strontium hydroxide to the acid compounds. The injections were given to dogs and rabbits. The early samples of tetraiodophenolphthalein were more toxic than the bromine salt. For this reason, in our early experiments we devoted more of our attention to the bromine compound.

I injected at least 200 dogs and rabbits without obtaining a single shadow of the gallbladder. From physiologic knowledge already obtained, we deduced that six to eight hours would be required after intravenous injection of one of these halogenated solutions for it to reach sufficient concentration in the gallbladder to cast a shadow. Accordingly, even in our early experiments, we would inject the animals at 8:30 or 9:00 A.M. and take roentgenograms at 4:30 or 5:00 P.M. Not having any x-ray equipment in our surgery laboratory, we had to transport the animals across the street to the x-ray room in the hospital. This task fell to my lot, since our laboratory assistants left the building at 5:00 o'clock, although they did kill the animals for me before they left. I shall always be most grateful to Miss O'Brien, who was the chief technician in the hospital x-ray room at the time, because she was extremely co-operative in taking the roentgenograms for me. She did not hesitate to stay overtime to make sure that we had good films. Since the roentgenograms were the crucial part of the experiment, one can understand how appreciative I was of this congenial co-operation; without Miss O'Brien's willingness, the experiment would have been much more difficult and perhaps discouraging.

THE FIRST SHADOW AND THE ROLE OF SERENDIPITY

After injecting over 200 animals without success, we finally obtained a gallbladder shadow (Fig. 4) in one of our dogs (November 1923). The shadow was so dense that I became convinced it would be reproducible in the human being. Miss O'Brien developed the film and, when she saw it, called out to me from the darkroom, saying she had something to show me. After confirming the shadow, I called Dr. Graham, who as usual was working late. He immediately dropped his work and was at the hospital in a few minutes. We both stood there admiring the dripping film with a white shadow in the center as if we had found the traditional pot of gold at the end of the rainbow. After a few moments

of silence, he slapped me on the back and announced enthusiastically: "Well, Warren, we have a muskie on the line and, if the line doesn't break or the boat capsize, we should land him."

My logbook, in which I kept records of these animals, disappeared, as did the x-ray film of the dog showing the dense shadow. Accordingly, I do not have the exact date when this first shadow was obtained, but I am sure it was sometime in the middle of November 1923, perhaps November 15. Incidentally, the notebook and film disappeared about the same time that we had a visitor in town. After returning from a meeting a couple of years later, Dr. Graham told me that he had been told by a friend that the visitor had the first cholecystogram in his possession. When Dr. Graham was asked about the film, his jaw would set squarely, he would mumble some profane words, and would look into space. A short time later, he told us he had the film, although he would never tell us exactly where it had been and how he obtained its return to St. Louis. Incidentally, Glover Copher told me a short time ago that this early animal film and the first human cholecystogram were still part of an exhibit on cholecystography in the Mallinckrodt Institute of Radiology.

This first visualization in the dog was obtained with calcium tetrabromphenolphthalein. We repeated the experiments on several animals during the next several days but did not obtain a single shadow. I went over the protocol of the animal that gave the positive shadow, trying to find a clue as to why it was positive and none of the others were, but I was not able to detect any difference in my technic. Needless to say, this was very discouraging, and in desperation I asked Bill, the animal caretaker, if the particular dog which gave the positive shadow had been treated in any way differently than the others. Bill thought for a minute and with some hesitation replied that he could not recall any differences in the treatment of the animals. I thought I had detected a slightly guilty expression on his face and, with the hope of breaking down any reticence, told him that this animal produced the results we were working for. With this statement his expression of apprehension changed completely, and after a few moments he remarked meekly, "Well, Dr. Cole, there *was* something different. I forgot to feed that dog the morning you injected him." He said this with great hesitation, presumably expecting a reprimand. I was so elated with this statement that I lunged at him, apparently like a wild animal, slapped him on the back and grasped his hand at the same time. He retreated backward, apparently thinking I was going to throttle him. However, I seemed so joyous over the occasion that he quickly lost his fear and became himself again.

I was aware of the report made by Boyden (6) at the annual meeting of the American Society of Zoologists that feed-

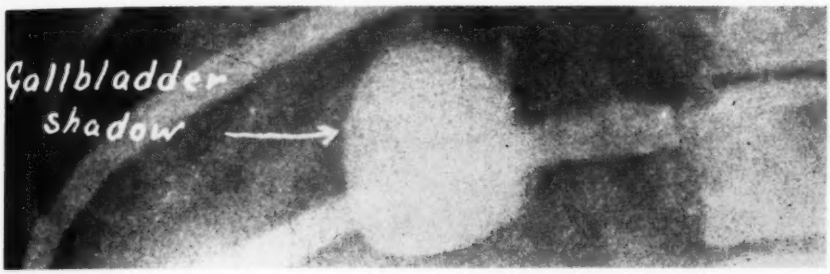


Fig. 4. The first successful cholecystogram in a dog. The animal, weighing 5.25 kg., was given 1.5 gm. of tetrabromphenolphthalein with 0.3 gm. of calcium hydroxide. (Reproduced by permission from Graham and Cole: J.A.M.A. **82**: 613, 1924.)

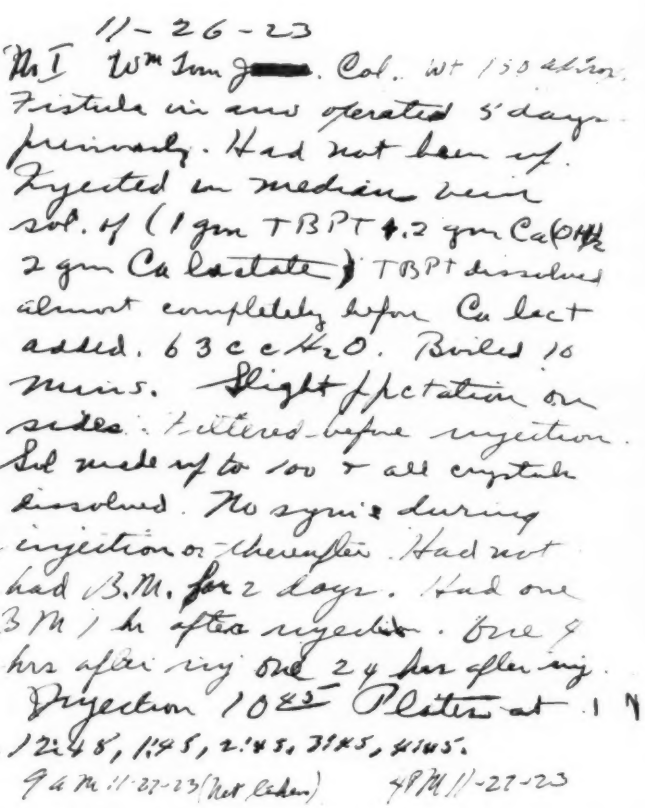

11-26-23
No I Wm Tom J[redacted]. Col. Wt 150 admitted
Fistula in ano operated 5 days
previously. Had not been inj.
Injected in median vein
sol. of (1 gm TBPT 4.2 gm CaOH
2 gm Ca lactate) TBPT dissolved
almost completely before Ca lact
added. 63 cc H_2O. Boiled 10
mins. Slight ppt on
sides. Filtered before injection.
Sol made up to 100 + all crystals
dissolved. No symptoms during
injection or thereafter. Had not
had B.M. for 2 days. Had one
B.M. 1 hr after injection. One ½
hrs after inj one 2 hrs after inj.
Injection 10:25 Plates at 1 ½
12:48, 1:45, 2:45, 3:45, 4:45.
9 a.m. 11-27-23 (Not taken) 4 P.M. 11-27-23

Fig. 5. Photograph of page 1 of my log book. We were using proper caution, as indicated by the fact that I gave this patient, the first one, only 1 gm. of tetrabromphenolphthalein. No reaction was sustained. (Reproduced by permission from Am. J. Surg., February 1960.)

ing (especially fat) was an important item in the filling and emptying of the gallbladder in animals, although he had not clarified the exact role it played in gallbladder function. Nevertheless, I felt confident that we had now found the key to the means of obtaining shadows and knew why our original experiments had been unsuccessful. Accordingly, I injected more animals after a short starvation period and obtained positive shadows in a high percentage. After demonstrating that the visualization could be duplicated at will, we moved rapidly to developing a technic which could be utilized in human beings.

We continued our experimentation with numerous drugs, most of which were halogenated phenolphthalein of some type or other. Altogether we tested 89 drugs, 13 of which (see Table I) would produce shadows of the gallbladder in animals. All except three or four, however, had serious drawbacks, such as severe toxicity, instability and high cost.

APPLICATION OF THE METHOD TO THE HUMAN BEING

Needless to say, we were gravely concerned about the toxicity of these halogenated compounds when we began their use in the human being. As stated previously, the compound was brought into solution only after the addition of an alkali; believing that the calcium or strontium salt would produce a better

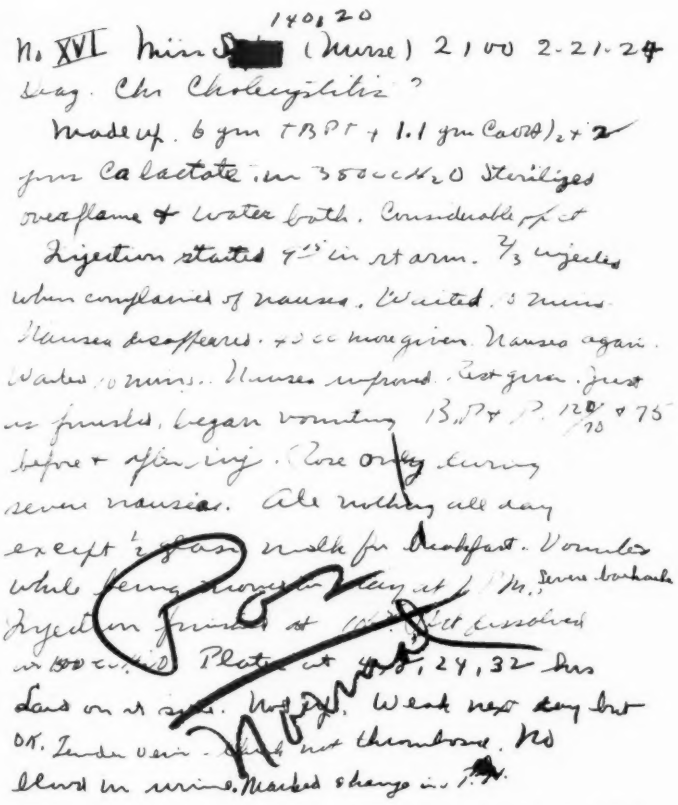


Fig. 6. Photograph of my notes on the first patient upon whom a definite cholecystographic shadow was obtained (see Fig. 7). She experienced severe nausea, back pain, and mild vomiting, and was extremely miserable. She was a nurse, and therefore I felt particularly apprehensive about her welfare. After about twenty-four hours, however, her symptoms disappeared, although she told me she had no appetite for days. (Reproduced by permission from Am. J. Surg., February 1960.)

shadow, we concentrated on these two elements as positive ions. Later we realized that the amount of calcium was so small compared to the halogen that there would be very little advantage of the strontium salt over the sodium. Moreover, the sodium salt was more physiologic.

By trial and error I learned that, for each gram of tetrabromphenolphthalein, 0.2 gm. of calcium hydroxide had to be added to 50 to 60 c.c. of distilled water to obtain solution of the compound. Even with this amount of alkali, it was necessary to grind the mixture with a mortar and pestle.

INTRAVENOUS USE OF CALCIUM TETRABROMPHENOLPHTHALEIN

Since we obtained the first shadow in the dog with calcium tetrabromphenolphthalein, we naturally decided to use this compound first in patients. We were very fearful of its toxicity, however, and began its use cautiously, as indicated by the reproduction (Fig. 5) of the page in my work book describing the injection in the first patient. We gave this first patient only 1 gm. of tetrabromphenolphthalein. We did not expect a shadow with this small dose, and we gradually increased the amount to 5 or 5.5 gm. Actually, we increased the dose 1 gm. per patient until

the fifth patient received 5 gm. The patient receiving 5 gm. displayed no reaction beyond a brief feeling of warmth over the entire body. Nor did the sixth patient, receiving 6 gm., sustain any reaction of greater intensity. By this time, however we apparently had used up our share of good luck, and serious reactions occured in several patients receiving 6 gm. We appreciated that this dose was too large and reduced it to 5 or 5.5 gm. Roentgenograms on the ninth patient did show a very faint shadow but we did not obtain a really good shadow until the sixteenth injection. Most of these patients had symptoms of gallbladder disease, and it is very likely that none of the modern compounds would have produced a shadow.

The sixteenth patient was a nurse who had pain in the right upper quadrant, with a questionable diagnosis of gallbladder disease. In this instance I mixed 6 gm. of tetrabromphenolphthalein with 1.5 gm. of calcium hydroxide and 2 gm. of calcium lactate and, after grinding the chemicals together, added distilled water up to 350 c.c. (Fig. 6). The injection was done on Feb. 21, 1924. Knowing that rapid injection in animals tended to increase reaction and even cause a drop in blood pressure, I started very slowly, particularly since the patient was one of our nurses at Barnes Hospital. My hopes of completing the injection uneventfully were blasted, although the reaction was not as serious as in some of the other cases. As indicated in the account in my logbook (Fig. 6), when about two-thirds of the material had been introduced, the patient began complaining of nausea. After a wait of ten minutes, the nausea disappeared and injection was resumed, but after introduction of about 40 c.c. the nausea returned. This was repeated a few times, an hour or two being utilized for completion of the injection. Just after it was finished the patient began vomiting, although her blood pressure and pulse remained stable. She remained nauseated for a couple of days and I felt very guilty at being responsible for her extreme discomfort. It is fortunate that we obtained a good visualization of her gallbladder because she was so miserable that I would certainly have lost a lot of my enthusiasm for continuing with the injections which to date had not yielded any good shadows of the gallbladder.

As I remember, the symptoms, which consisted of pain in the right side of the abdomen, particularly the upper quadrant, later were proved to be of renal origin, although the patient had very few urinary symptoms at the time. At least we were able to tell her that her gallbladder was normal and thus probably saved her a needless cholecystectomy, which might have been advised erroneously because the urinary findings were not as clear-cut as they should have been.

This shadow, which was a very dense one (Fig. 7) gave us renewed enthusiasm, since we were now convinced that the theory of producing a shadow of a normal gallbladder in the human being was valid. We had no idea as to how often the medium would get into the gallbladder containing stones, and just what the contrast of the stones with the opaque medium would look like.

ROLE OF GASTRIC CONTENT ON TONUS OF THE SPHINCTER OF ODDI

The importance of an empty stomach for the production of a positive gallbladder shadow was so striking that I decided it was essential to have more data on this point if we were to obtain optimum shadows. Accordingly, I planned a series of experiments on dogs, for observing the effects of various foods and chemicals in the duodenum and stomach on the tonus of the sphincter of Oddi (7). By inserting a cannula in the proximal end of the common duct of a dog and attaching it to a bottle containing saline colored with methylene blue, I was able to determine the pressure required to force fluid through the sphincter of Oddi. An incision 2 inches long was made in the duodenum over the ampulla of Vater, and the pylorus as well as the cardia was occluded with a ligature. I then removed the gastric contents through a small incision into which

was fitted a T-tube through which the stomach could be irrigated.

Various solutions and food mixtures were placed in the stomach, and the pressure reading required to break through the sphincter of Oddi was recorded. With an empty stomach the pressure necessary varied between 40 and 100 mm. of water. Irrigation of the stomach with physiologic saline required 10 to 30 mm. of pressure. When 75 to 150 c.c. of 0.5 per cent of sodium hydroxide were put into the stomach, the amount of pressure necessary to force fluid through the sphincter of Oddi rose to a point between 100 and 125 mm. When the sodium hydroxide was replaced with 0.5 per cent hydrochloric acid, the requirement dropped 75 to 100 mm. It was apparent that maintaining an alkaline medium in the stomach would cause a contraction of the sphincter of Oddi, thus allowing a better flow of bile into the gallbladder, where concentration could then take place most effectively. Actually these experiments were so conclusive that we adopted the principle of giving 2.5 gm. of sodium bicarbonate every three hours while the patient was awake during the first twenty-four to forty-eight hours following administration of the medium.

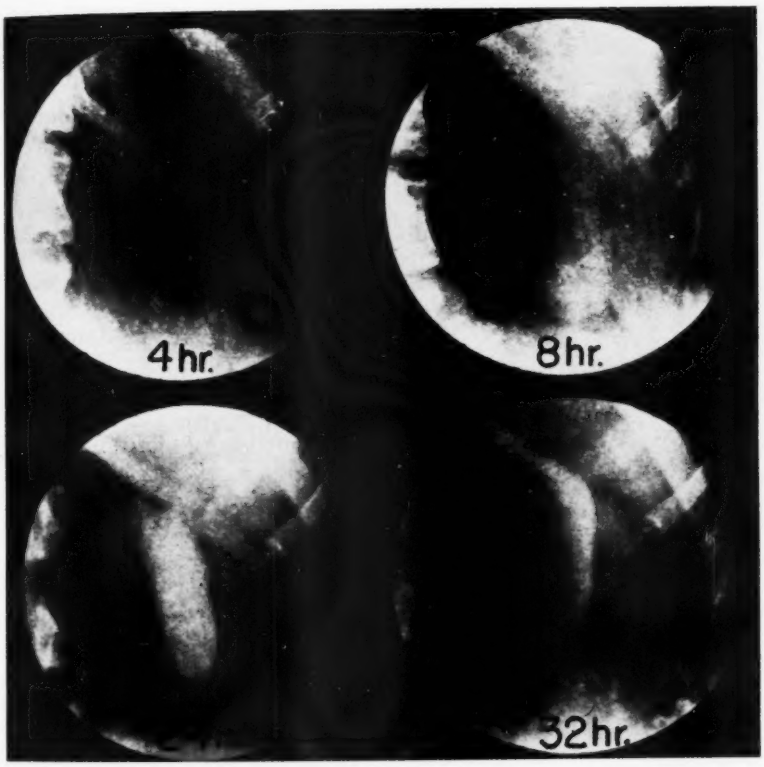


Fig. 7. The first successful cholecystogram in the human being, obtained Feb. 21, 1924. The patient received 5.5 gm. of tetrabromphenolphthalein. Films were taken at four, eight, twenty-four, and thirty-two hours. No shadow is seen on the four-hour film; on the eight-hour film the shadow is large and faint. A dense shadow is observed at twenty-four hours. The persistence of the shadow is attributed to the prolonged starvation period. (Reproduced by permission from Graham, Cole, Copher, and Moore: Diseases of the Gall Bladder and Bile Ducts. Philadelphia, Lea & Febiger, 1928.)

STANDARDIZATION OF TECHNIC AND USE OF VARIOUS COMPOUNDS

After modifying our procedure slightly

for the first 20 or 30 cases, we were able to arrive at some conclusions concerning a standard technic. These were described in our first report (1924) on visualization of the gallbladder (8) and seemed so pertinent and so peculiar to us now that I am quoting from that report.

"Six grams of tetrabromphenolphthalein are mixed with 1.2 gm. of calcium hydroxide, ground in a mortar with a few cubic centimeters of water, and dissolved in from 325 to 350 c.c. of distilled water. Addition of calcium lactate was found to produce a more stable solution and slightly increase its solubility. Therefore, a solution of 2 gm. of calcium lactate in a few cubic centimeters of water is added. The solution has been sterilized by heating it to the boiling point over a flame, and maintaining the temperature between 95 and 100° C. for fifteen minutes. Occasionally, a small amount of the calcium salt precipitates on the bottom of the receptacle. This dissolves readily on the addition of a small amount of water or saline solution after the clear solution is decanted off. The solution is filtered and given intravenously by the gravity method, similar to an arsphenamine injection. The solution is introduced slowly. Usually from twenty-five to thirty minutes is consumed in the injection, so that symptoms, if present, can be detected early. Roentgenograms of the gallbladder region are taken at intervals of several hours, beginning three hours after the injection."

Orders, as listed in our second report (9), were as follows:

"1. Omit breakfast.
"2. Omit lunch (a glass of milk may be given if hunger is too pressing).
"3. Take 40 gr. (2.6 gm.) of sodium bicarbonate every three hours for forty-eight hours, day and night, while awake.
"4. Lie on the right side of the abdomen or be up.
"5. Take water, if desired, by mouth.
"6. Omit protein from the evening meal on the day of injection."

"X-ray films are then taken at four, eight, twenty-four, and thirty-two hour periods (no special technic)."

INTRAVENOUS USE OF SODIUM TETRABROMPHENOLPHTHALEIN

In this period when cholecystography was being developed, we were just becoming aware of toxic effects which were later ascribed to pyrogens. Severe reactions, including chills, fever, etc., were obtained occasionally after the administration of physiologic saline or 5 per cent glucose intravenously. With this possibility in mind, we decided that we should try the sodium salt of tetrabromphenolphthalein, since we knew that this compound was very soluble and could be injected in no more than 20 to 40 c.c. of fluid. It appeared that the large amount of fluid necessary to obtain a solution with the calcium salt might be responsible for the reactions, although we considered the possibility that the calcium salt itself might have a toxicity not possessed by some of the other salts, particularly sodium tetrabromphenolphthalein. Accordingly, we changed immediately to the sodium salt. For a time I made it myself, using sodium hydroxide to bring the tetrabromphenolphthalein into solution. By this time, the usefulness of the method was sufficiently established to convince the Mallinckrodt Chemical Works that they should prepare the sodium salt for commercial purposes. Upon request, they agreed to do this, partially putting me out of the pharmaceutical manufacturing business, though I still had to dissolve the agent and sterilize the solution. Actually, I believed that having them make the salt would possibly eliminate the reactions. I remember, however, that the reactions from solutions made from the salt prepared by them were just as common as they were from the sodium salt I made. I was anxious to be relieved of this extra task because I wanted to spend the time on a search for better chemicals and a wider application of the process, namely, visualization of the kidneys, spinal canal, and cerebral ventricles.

Knowing that we could give sodium tetrabromphenolphthalein slowly without any reaction during the first half of the injection, we decided to give the solution in two injections of 20 c.c. each, one half-hour apart. This reduced the reactions considerably and we maintained the principle of giving the medium in two doses even after we began the use of sodium tetraiodophenolphthalein and sodium phenoltetraiodophthalein. During injection of this concentrated material, the patient

would often display minor symptoms, which would be relieved if the injection was terminated for five or six minutes. This made it essential to devise a means of injecting the solution for a time and alternating with injection of physiologic saline to maintain patency of the vein. Accordingly, I devised a carrier (Fig. 8) for the two 20-c.c. syringes; in one we placed physiologic saline and in the other the medium. These syringes simplified the injections and minimized the danger of extravasation and the production of a slough, which would occur if more than 1 or 2 c.c. of the concentrated solution escaped outside the vein.

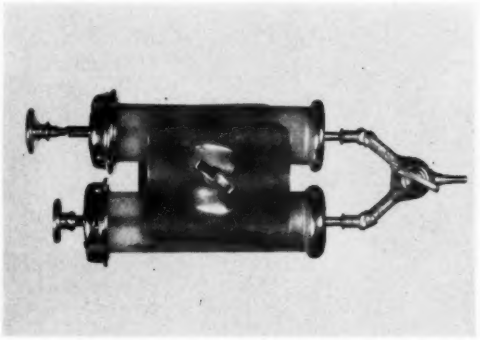


Fig. 8. Carrier for two syringes devised to allow alternate injections of physiologic saline solution and dye. This made it possible to stop the injection temporarily (and keep the needle open with saline) if a reaction was sustained. Often, early mild symptoms would disappear in a few minutes if the injection were stopped or the rate decreased. (Reproduced by permission from Am. J. Surg., February 1960.)

INTRAVENOUS USE OF SODIUM TETRAIODOPHENOLPHTHALEIN

Shortly after we started using sodium tetrabromphenolphthalein we began the use of sodium tetraiodophenolphthalein because the atomic weight of iodine is so much greater than that of bromine (127 *versus* 80). It was obvious that a substance with a higher atomic weight would be more impervious to the x-ray. As stated previously, we began the use of the tetraiodophenolphthalein compound before the bromine compound, but dropped it because of its greater toxicity. Unknown to us Whitaker and Milliken (10) were also working on the comparative usefulness of sodium tetraiodophenolphthalein. Their article and ours (11) recommending the use of sodium tetraiodophenolphthalein appeared in print in January 1925.

ORAL ADMINISTRATION OF SODIUM TETRAIODOPHENOLPHTHALEIN

Since the intravenous administration of any diagnostic or therapeutic agent is more complicated than the oral, it was obvious that attempts should be made to administer cholecystographic media by mouth. In September 1925 we reported (12) our comparative experiences with intravenous and oral methods, noting that the shadows could be obtained with the oral method, although the accuracy seemed greater following intravenous injection (Fig. 9). A short time later, Menees and Robinson (13) reported fairly accurate interpretation of gallbladder shadows following the oral use of sodium tetraiodophenolphthalein. Both groups of investigators noted that 3.5 gm. was an adequate dose for adults. Obviously, the interval for taking films would be different than with the intravenous method, in view of the slower excretion following oral administration. Accordingly, with the oral method we took films fourteen, eighteen and twenty-four hours after administration of the medium.

Shortly after this, most clinicians adopted the oral route because administration by this method was more convenient. Also the reactions were less serious, even though they were more common (Table II). A big disadvantage of the oral method was that vomiting or diarrhea commonly developed. As a result of vomiting, the patient might not absorb enough of the medium to produce a shadow; accordingly, the test would have to be repeated or an intravenous examination be done. We did note that vomiting could be avoided by coating the capsule with some substance (*e.g.*, keratin) which was not absorbed in the stomach. This prevented the vomiting but did not eliminate diarrhea.

SIMULTANEOUS CHOLECYSTOGRAPHY AND LIVER FUNCTION

Early in our investigations we began experimenting in the laboratory with the phenoltetrahalogenphthalein compounds which are isomers of the tetrahalogenophenolphthaleins. Sodium tetraiodophenolphthalein is a blue powder which, when dissolved in water, produces a blue solution that does not stain the blood serum. Sodium phenoltetraiodophthalein is a purple powder producing a beautiful fluorescent color in solution that will stain a tube of blood serum to which a drop of sodium hydroxide (10 per cent) has been added. A few years previous to this work, Rowntree and associates (14) had published data indicating that phenoltetrachlorphthalein was useful in determination of liver function. Preliminary experiments with phenoltetraiodophthalein indicated that it would produce shadows as dense as the tetraiodophenol compound; in fact, no more than 2.5 gm. of sodium salt was necessary for a good shadow of a normal gallbladder.

Fig. 9. Normal cholecystogram after oral administration of medium. A. Fifteen hours after ingestion. B. Nineteen hours. C. Twenty-three hours. (Reproduced with permission from Graham, Cole, Copher, and Moore: Diseases of the Gall Bladder and Bile Ducts. Philadelphia, Lea & Febiger, 1928.)

The above data revealed that phenoltetraiodophthalein was effective as a diagnostic test, and that information could be obtained on liver function as well as gallbladder function (15). In this simultaneous technic we adopted a dose of 40 mg. per kilogram of body weight. Since a much smaller amount of medium was used in the other liver function tests, it occurred to us that this larger dose might detect

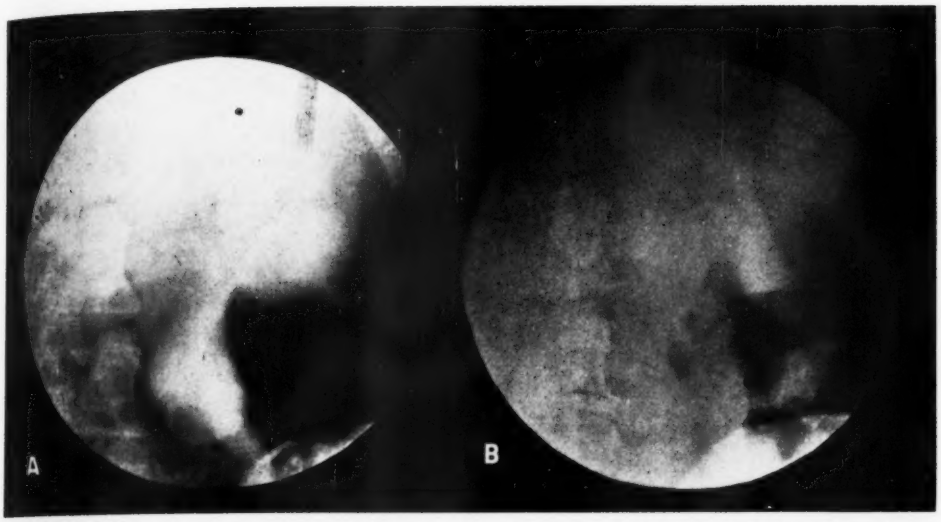


Fig. 10. Effect of fat meal. A. Normal cholecystographic shadows after intravenous injection of phenoltetraiodophthalein. B. The same gallbladder one hour after the patient had ingested 1/2 pint of cream and the yolks of three eggs. (Reproduced by permission from Graham, Cole, Copher, and Moore: Diseases of the Gall Bladder and Bile Ducts. Philadelphia, Lea & Febiger, 1928.)

disturbances of liver function with more intensity than would the routine tests devised prior to our experiments. In 1925, when we were studying this problem, Rosenthal and White (3) reported on the successful use of Bromsulphalein for determination of hepatic function. They adopted the use of 2 mg. per kilo.

Before injecting the phenoltetraiodophthalein, we removed 7 or 8 c.c. of blood from the patient to be used as a control. Other samples of blood were taken thirty minutes and sixty minutes after injection of the dye. The serum was separated from the blood by centrifugation and a drop of 10 per cent sodium hydroxide put into each of the thirty and sixty minute samples. Utilizing a comparator box, as recommended by Rosenthal, we then determined the amount of dye remaining in the serum. We noted that a retention of 10 to 12 per cent in thirty minutes, and 5 per cent or less in sixty minutes, was normal. In our work with phenoltetraiodophthalein this test appeared to be quite accurate, and was very helpful in determining operability. For example, after data on 100 or more tests of liver function with phenoltetraiodophthalein, we learned that three of our patients having choledochostomy for stone and cholecystectomy had died. One patient was jaundiced and it is probable that the bilirubin in the serum intensified the discoloration of the serum by the medium. A second patient was also jaundiced and had a retention of 60 per cent in thirty minutes. Cholecystectomy was performed along with the removal of an intraligamentous cyst in the broad ligament, which should not have contributed significantly to the mortality. The third patient was not jaundiced, and yet had a retention of 90 per cent in thirty minutes. At operation, a duodenal ulcer was found to be present in addition to gallstones. A gastroenterostomy and cholecystectomy were performed.

During this period of observation, we had no other deaths following cholecystectomy. Since all three deaths occurred in patients with severe retention of dye following the test, we became very cautious about operating in the face of a high retention of phenoltetraiodophthalein. At that time we recognized that administration of glucose and blood as well as correction of malnutrition would be helpful in reducing

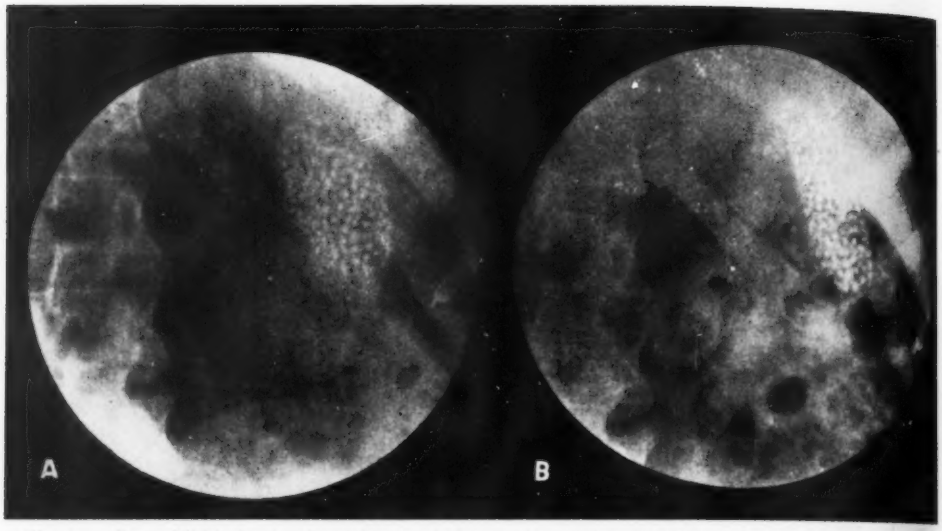


Fig. 11. Case of lithiasis, showing evidence of change of tonus in gallbladder. A. Phase of relaxation. B. Tonic phase. (Reproduced by permission from Graham, Cole, Copher, and Moore: Diseases of the Gall Bladder and Bile Ducts. Philadelphia, Lea & Febiger, 1928.)

the liver retention. We concluded that, if a significant retention was present, either the operation should be cancelled or a minimal amount of surgery should be done at that time. Actually the average retention found in our patients with chronic cholecystitis without jaundice was 27 per cent in thirty minutes. During this period we had only one patient with virus hepatitis (then designated as catarrhal jaundice); this patient had a retention of 90 per cent in thirty minutes, confirming what is known today about the severe liver damage usually produced by this disease. The jaundice no doubt intensified the color of the dye in the serum, but there must have been some truth in the readings because the average retention in our patients with jaundice due to gallstones was only 55 per cent, and in patients with jaundice due to carcinoma of the pancreas and liver was only 25 per cent in thirty minutes.

We found that 85 per cent in thirty with gallbladder disease had a retention above normal. It was also noted that the retention was higher in those having symptoms of long duration. We had evidence, however, that an elevated retention in the absence of jaundice did not necessarily indicate that the liver would be unable to excrete enough dye for production of a shadow. On numerous occasions normal cholecystograms were obtained in patients with retention as high as 50 or 60 per cent thirty minutes after injection. However, we granted that severe liver damage might prevent sufficient excretion of dye for production of a gallbladder shadow even if the gallbladder was normal. We learned early that we were unable to obtain a shadow of the gallbladder in the presence of jaundice, regardless of its cause. Fried and Whitaker (16) confirmed our impression that considerable liver damage was necessary before it would prevent production of a shadow in a normal gallbladder; their experiments were done on dogs, with tetraiodophenolphthalein.

INTERPRETATION OF ROENTGEN SHADOWS

Very shortly after we obtained the first positive shadow of the gallbladder, we invited Dr. Sherwood Moore, head of the Department of Radiology at Washington University School of Medicine and Barnes Hospital, to collaborate with us, realizing that there would be many diagnostic prob-

lems in interpretation of the cholecystographic shadows. There was considerable controversy in the medical literature as to whether or not the gallbladder wall had sufficient muscle power to induce a peristaltic action. In fact, all normal gallbladder shadows observed for several hours usually decrease in size after a meal

Fig. 12. At operation for chronic appendicitis the gallbladder was found free and pendulous. The condition observed in the cholecystogram was obviously due to the organ being folded up on itself and not to adhesions. (Reproduced by permission from Graham, Cole, Copher, and Moore: Diseases of the Gall Bladder and Bile Ducts. Philadelphia, Lea & Febiger, 1928.)

containing fat (Fig. 10). This feature was, of course, not so much related to the question of disease as it was to the mechanism of emptying.

We continued numerous minor experiments, trying to demonstrate deformities which might be interpreted as muscle contraction, but we were never convinced that we saw a peristaltic wave in a gallbladder. It did appear, however, that the decrease in size was an expression of a gradual contraction of the muscle layer (Fig. 11).

Early in our experience, we appreciated the fact that the lack of a shadow implied a diseased gallbladder. Indeed, before we obtained the first positive film we anticipated that all the normal, or near normal, gallbladders would produce a shadow. One of the big problems with which we

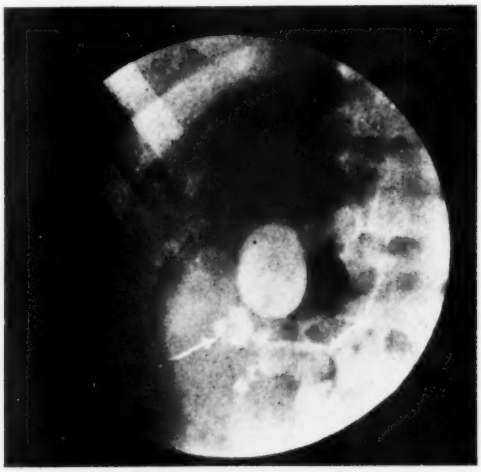


Fig. 13. Multiple right renal stones. Normal gallbladder. The left arrow indicates kidney calculi, thought to be gallstones; right arrow indicates a pelvic stone. (Reproduced by permission from Graham, Cole, Copher, and Moore: Diseases of the Gall Bladder and Bile Ducts. Philadelphia, Lea & Febiger, 1928.)

were confronted, and which Doctor Moore studied in detail, was the interpretation of a faint shadow. Our impression then was similar to our impression now, namely, that it could represent a mild disease of the gallbladder wall. The filling defects of stones were of course self-explanatory and were expected before we actually encountered them.

A typical finding that gave us special difficulty and perhaps misled us most was the deformed shadow. I shall always remember our deep chagrin upon finding a normal gallbladder in a young female patient who had a badly deformed shadow (Fig. 12). We had thought that this represented pericholecystitis, but on operation for pain in the right upper quadrant and to the right of the umbilicus, we found an entirely normal gallbladder but a retrocecal appendix causing the symptoms. Having seen one concrete example of a gallbladder folded because of pressure during the taking of the roentgenogram, we were able to eliminate that cause of error in interpretation thereafter.

Early in our work we realized that demonstration of a normal gallbladder shadow could be of just as much diagnostic value as an abnormal film (*i.e.*, no shadow).

Figure 13 is a cholecystogram obtained in a patient who had asymptomatic kidney stones and was about to have a cholecystectomy (or celiotomy) because of opaque shadows thought to be gallstones. Figure 14 illustrates an equally important use for cholecystography, which pleased us very much; this patient had attacks of pain in the right upper quadrant which were typical for gallbladder disease. The cholecystogram, however, was normal; a careful history and investigation showed that the patient had an allergy to chocolate and had had three attacks shortly after eating chocolate candy. I did not realize that we had utilized change in position of the patient from prone to erect in order to accentuate the shadow of gallstones, but Figure 15, obtained from our gallbladder book, illustrates the point, which Dr. Moore had developed.

Fig. 14. Cholecystograms, which are normal, in a patient upon whom a clinical diagnosis of cholecystitis was made, but whose symptoms were found to be actually the result of an intestinal allergy to chocolate. (Reproduced by permission from Graham, Cole, Copher, and Moore: Diseases of the Gall Bladder and Bile Ducts. Philadelphia, Lea & Febiger, 1928.)

We presented papers on cholecystography at various medical meetings but immediately transferred to Dr. Moore the presentation of the subject before radiology meetings. For some strange reason, cholecystography was received with less enthusiasm by the radiologists than by our other friends. Perhaps it was because the criteria for diagnosing gallbladder disease by indirect methods and by the shadow of the thickened wall were just being advanced. It was very amusing to have Dr. Moore (17) describe to me, as he did a short time ago, some of the cool receptions he received at the radiological meetings.

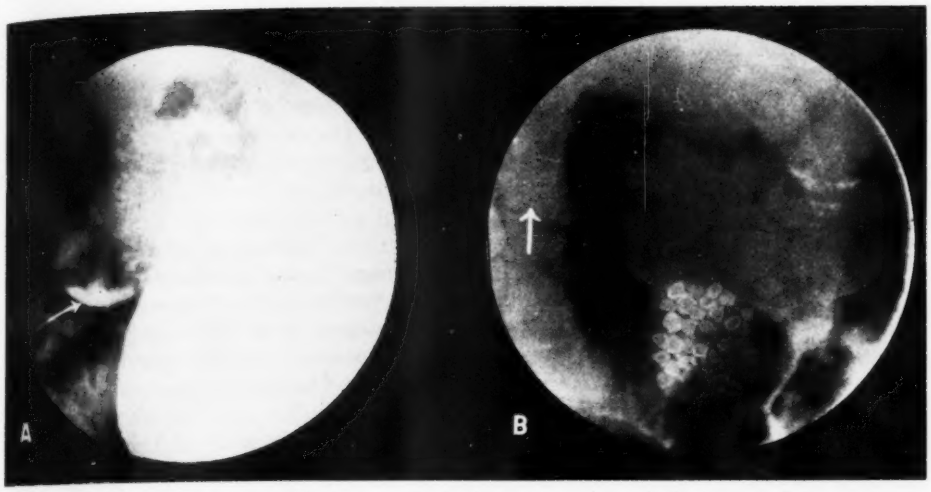


Fig. 15. Multiple gallstones. A. Patient erect. B. Patient prone. Arrow indicates a small stone, presumably in the common duct. Doctor Moore in these early years of cholecystography had noted the value of change in position for detection of gallstones. (Reproduced by permission from Graham, Cole, Copher, and Moore: Diseases of the Gall Bladder and Bile Ducts. Philadelphia, Lea & Febiger, 1928).

At one meeting, he told me, a member of the audience arose in discussion to denounce cholecystography as being worthless, adding that anyone giving the medium by vein "should be put in jail." At another meeting, someone denounced the procedure in a paper entitled, "Gall and Gallbladder Diagnosis." That, said Dr. Moore, was the most venomous attack he had ever heard delivered in public against any method or procedure. I am not relating these incidents to indicate that the radiologists were giving our procedure inadequate attention, for some of my best friends have always been radiologists. I am merely bringing them up because such attitudes develop everywhere and are actually healthy, aiding in discrimination of worthy or worthless projects.

Among the many favors Dr. Moore extended me, I appreciated one particularly. He appointed Dr. Louis Aitken as an assistant in the department to give the injections, shortly after we began the use of sodium tetraiodophenolphthalein intravenously. This released to me a lot of time which I wanted to devote to further work in the laboratory, and I was very grateful to be relieved of the routine task. In a recent communication, Dr. Aitken(18) told me about some of his experiences with the drug. He encountered numerous minor reactions but, true enough, he seldom saw a serious one such as vascular collapse. He did recall one very strange reaction which for a time was difficult to explain. This patient was so apprehensive that he experienced hyperventilation followed by carpopedal spasm and fixation of the jaw. We thought this reaction was due to the medium, but could not recall anything similar to it. We were about to add this as another type of reaction to the long list already observed when Dr. Aitken discovered that the patient had been taking a large amount of alkali (citrocarbonate) to counteract ulcer symptoms, and had developed an alkalosis tetany.

To prevent spasm of veins during injection, Dr. Aitken began the procedure of injecting the solution through the rubber tubing of the intravenous set. This was a definite advance in so far as it eliminated almost completely the danger of extravasation, which would be serious if it were allowed to take place unnoticed. Extravasation, however, usually resulted in so much pain immediately after its development that we became aware of it shortly after it began.

TABLE II: REACTIONS TO VARIOUS CONTRAST MEDIA USED IN EARLY CHOLECYSTOGRAPHY*

Reaction	No. of Cases	Per Cent
TETRAIODOPHENOLPHTHALEIN (300 CASES)		
Intravenous method:		
No reaction	96	46.9
First-degree reaction	75	36.6
Second-degree reaction	34	16.5
TOTAL	205	...
Oral method:		
No reaction	31	33.3
First-degree reaction	17	18.3
Second-degree reaction	45	48.7
TOTAL	93	...
Rectal method (No reaction except difficulty in retaining the solution)	2	...
PHENOLTETRAIODOPHTHALEIN (FIRST 487 CASES)		
Intravenous method:		
No reaction	297	61.5
First-degree reaction	130	27.3
Second-degree reaction	54	11.2
TOTAL	481	...
Oral method:		
No reaction	3	50.0
First-degree reaction	2	33.3
Second-degree reaction	1	16.6
TOTAL	6	...
PHENOLTETRAIODOPHTHALEIN (200 SUBSEQUENT CASES)		
Intravenous method:		
No reaction	136	68.0
First-degree reaction	51	25.5
Second-degree reaction	13	6.5
TOTAL	200	...

* Modified from: Graham, E., Cole, W., Copher, G., and Moore, S.: Diseases of the Gallbladder and Bile Ducts. Philadelphia, Lea & Febiger, 1928.

REACTIONS TO ORAL AND INTRAVENOUS CHOLECYSTOGRAPHY

I need not remind the older members of this Society that the reactions to the halogenated phenolphthalein compounds used in cholecystography were frequent and sometimes alarming. These reactions were most common and perhaps most severe following the intravenous administration of calcium tetrabromphenolphthalein which was so insoluble it had to be dissolved in 300 to 350 c.c. of distilled water. Since the toxicity of the bromine and iodine compounds was found to be approximately the same, it appears that pyrogens in the water may have been responsible for some of the reactions. We discovered early in our experimental work that drug reactions were due to the phenolphthalein radical and not to the bromine or iodine. One of the remarkable things I have been unable to understand was the fact that, even though these reactions were frequent and severe in type, fatalities were practically non-existent. For example, among the 2,000 or 3,000 patients to whom we gave the drug only one death occurred, and this could probably not be classified as a drug fatality from the injection. The patient was a woman about sixty-eight years of age who had a fairly severe reaction consisting of nausea, vomiting, vertigo, and chills; but she had no significant change in pulse rate or blood pressure; she died of a vascular collapse during the night (about twenty hours after the injection). We were unable to obtain an autopsy but, since the death resembled a coronary occlusion so closely, that explanation would appear to be more likely than a reaction to the drug. Actually, we were able to find in the medical literature the records of only one death which definitely was attributable to injection of the cholecystographic medium. This patient received 5.5 gm. of tetraiodophenolphthalein which is a much larger dose of that drug than we had given.

Needless to say these reactions were very troublesome to us, and we tried numerous procedures to avoid them. In Table II are listed the reactions occurring in the first one thousand cases. In this compilation we have designated as first-degree reactions headache, vertigo, slight nausea, weakness, backache, and urticaria. Second-degree reactions consisted of severe nausea and vomiting, chill, circulatory depression, and severe abdominal cramps. If more than one symptom of the first-degree type were encountered, the reaction was classified as second-degree. With very few exceptions, the patient recovered rapidly from the reactions, and was reasonably comfortable three to five hours after termination of the injection. As noted in the table, the incidence of reactions was greater following the oral method than after the intravenous, but they were more severe after the latter. Fortunately, not over 5 to 8 per cent of the patients re-

ceiving the drug intravenously sustained a circulatory reaction with a significant drop in blood pressure.

Dr. James Case, a radiologist, began the use of cholecystography soon after we reported it. We obtained considerable gratification from his experiences, since he told us that in more than 1,600 injections for cholecystography only one patient gave him serious concern from the standpoint of reaction. He noted that, if a vascular depression was sustained, the use of adrenalin intramuscularly or in small doses intravenously would bring the blood pressure back to normal. After we encountered a fall in blood pressure in a few cases following injection, we began the use of a few minims intramuscularly just before the injection. I shall never forget one patient who had a rather sharp fall in blood pressure, for which we gave two or three minims of adrenalin intravenously; the pressure rose sharply to over 200, and she complained bitterly of severe headache. I am glad indeed that this patient was young since in an older person such a sharp rise in pressure might have produced a serious cerebral vascular complication. Following this experience we gave no more adrenalin intravenously. It is true that the incidence of reactions declined somewhat as time progressed, but they were never obliterated with the bromine and iodine compounds given either orally or intravenously.

The use of the double syringe (see Fig. 8) did reduce the incidence of reactions following intravenous injection, largely because we could slow down the injection of the drug without danger of clotting in the vein, by simply turning the stopcock and injecting physiologic saline to keep the vein open.

Looking back over some of our reprints, I find that we listed "threatened uremia" as a contraindication. It is difficult now to realize just why we considered this a contraindication, but I suppose we must have encountered a serious reaction in some patient who had a high non-protein nitrogen.

MODIFICATIONS OF TECHNIC

Within two or three years after introduction of cholecystography, dozens of modifications had been suggested. Most of them appear absurd now and some did so even then. I confess I am not very proud of the fact that we ourselves contributed some of those modifications, although we actually did not use them extensively. The introduction of the fat meal after a shadow had been obtained was more logical than most of the others, even though it was soon omitted. It was originally given to find out if the gallbladder was able to contract. Failure to obtain a decrease in the size of the shadow after administration of the fat meal would indicate that the gallbladder wall was diseased to such an extent that the muscular layer was not functioning. We learned later, however, that the ability to concentrate the dye or medium was more important than contractility, so important, in fact, that observation on contractility was unnecessary.

To minimize the reactions following oral administration, numerous workers including ourselves, had the capsule coated with various substances (*e.g.*, salol, phenyl salicylate, and keratin) to prevent it from being dissolved in the stomach so rapidly that it might produce nausea and vomiting. Unfortunately, these coated capsules frequently passed through the entire gastrointestinal tract intact. This obviously would jeopardize production of the shadow and might lead to an erroneous interpretation. Fortunately, these undissolved capsules could be seen on the x-ray film. When they were encountered, the test would have to be repeated, if no shadow or only a light shadow was obtained. To prevent this failure of dissolution of the capsules, Levyn and Aaron(19) recommended placing one inside another, with powdered sodium bicarbonate between. The theory behind this modification was that the sodium bicarbonate surrounding the capsule of medium would prevent the formation of the hard insoluble acid which would be produced by the acid

in the stomach, if the capsule dissolved there. We did not try this but did adopt for a time the suggestion of Larimore(20), working in our clinic, that powdered agar and sodium bicarbonate be put in the capsule with the medium. This truly prevented formation of non-soluble capsules, although addition of these two substances made it necessary for the patient to take more capsules to get the 4 or 5 gm. of tetraiodophenolphthalein necessary for good shadows. One author stated that if 3 or 4 gm. of sodium tetraiodophenolphthalein were mixed thoroughly in a small bowl of Cream of Wheat, no medium would be left unabsorbed and a smaller dose would be needed.

Fantus (21) reported that he was able to eliminate nausea and vomiting, and lack of absorption, by giving the medium in a colloidal form. He passed carbon dioxide through a solution of tetraiodophenolphthalein until it was discolored, or added carbonated water until a suspension was formed. The addition of dilute tragacanth mucilage was necessary to stabilize the suspension. This suspension was white in color and did not have the disagreeable taste of the regular powder. We tried this technic and confirmed Fantus' claims, but shortly abandoned it because it was a bit too complicated for routine use.

On several occasions we injected the medium rectally, but severe tenesmus and diarrhea resulted. For some unexplained reason, I also injected a dilute solution of sodium tetraiodophenolphthalein subcutaneously into rabbits, but to this day I do not understand why I wasted my time on such a procedure because a local irritating effect would certainly be produced by the drug. I suppose I became so disturbed with the reactions with oral and intravenous methods that I was grasping for straws, hoping to find a procedure which would eliminate them. Strangely enough, shadows of the gallbladder were reproduced in rabbits following this technic, but we never tried it in the human being.

Before introduction of the modern drugs which have eliminated reactions completely, or nearly so, numerous chemicals were suggested and reported as being effective in producing shadows. Sabatini and Milani (22) reported that oral administration of 10 to 20 gm. of sodium and strontium bromide would produce gallbladder shadows if the patient was fasted for a long time preceding injection of the drug. We tried this and somewhat to my surprise confirmed their claims, although the shadows were not dense enough to be reliable.

ACKNOWLEDGMENTS: I want to express my appreciation to Dr. Wendell Scott of the Department of Radiology, Washington University, St. Louis, for finding some of my old notebooks used in recording the early experiments and for accumulating numerous bottles containing compounds used in these experiments; he assembled these for an exhibit displayed in the Mallinckrodt Institute. I wish also to thank Dr. Hugh Wilson, Professor of Radiology, Washington University, who sent me some of the material from this exhibit, which I used for preparation of this article. To Mr. Edward Mallinckrodt, Jr., we are grateful indeed for the Edward Mallinckrodt Institute of Radiology which was completed in 1931, and donated to Washington University. We would like to think that the development of cholecystography might have been a factor stimulating Mr. Mallinckrodt to donate this magnificent building to Medicine and to the people of St. Louis.

840 South Wood St.
Chicago 12, Ill.

REFERENCES

1. ABEL, J. J., AND ROWNTREE, L. G.: On the Pharmacological Action of Some Phthaleins and Their Derivatives, with Special Reference to Their Behavior as Purgatives. J. Pharmacol. & Exper. Therap. 1: 231–264, August 1909.

2. ROUS, P., AND MCMASTER, P. D.: The Concentrating Activity of the Gallbladder. J. Exper. Med. **34:** 47–73, July 1921.

3. ROSENTHAL, S. M., AND WHITE, E. C.: Clinical Application of the Bromsulphalein Test for Hepatic Function. J.A.M.A. **84:** 1112–1114, April 11, 1925.

4. COLE, L. G.: Roentgenographic Diagnosis of Gall Stones and Cholecystitis. Surg., Gynec. & Obst. **18:** 218–227, February 1914.

5. GEORGE, A. W., AND LEONARD, R. D.: Roentgen Diagnosis of a Pathological Gallbladder. Am. J. Roentgenol. **4:** 321–335, July 1917.

6. BOYDEN, E. A.: The Gallbladder in the Cat. Anat. Rec. **24:** 388, 1922–23; Effects of Natural Foods on the Distension of the Gallbladder, with a Note on the Change in the Pattern of the Mucosa as It Passes from Distension to Collapse. Anat. Rec. **30:** 333, 1925.

7. COLE, W. H.: Relation of Gastric Content to the Physiology of the Common Duct Sphincter. Am. J. Physiol. **72:** 39–42, March 1925.

8. GRAHAM, E. A., AND COLE, W. H.: Roentgenologic Examination of the Gallbladder; New Method Utilizing Intravenous Injection of Tetrabromphenolphthalein. J.A.M.A. **82:** 613–614, Feb. 23, 1924.

9. GRAHAM, E. A., COLE, W. H., AND COPHER, G. H.: Visualizing of the Gallbladder by the Sodium Salt of Tetrabromphenolphthalein. J.A.M.A. **82:** 1777–1778, May 31, 1924.

10. WHITAKER, L. R., AND MILLIKEN, G.: Comparison of Sodium Tetrabromphenolphthalein with Sodium Tetraiodophenolphthalein in Gall-Bladder Radiography. Surg., Gynec. & Obst. **40:** 17–23, January 1925.

11. GRAHAM, E. A., COLE, W. H., AND COPHER, G. H.: Cholecystography: An Experimental and Clinical Study. J.A.M.A. **84:** 14–16, Jan. 3, 1925.

12. GRAHAM, E. A., AND OTHERS: Cholecystography; Oral Administration of Sodium Tetraiodophenolphthalein. J.A.M.A. **85:** 953–955, Sept. 26, 1925.

13. MENEES, T. O., AND ROBINSON, H. C.: Oral Administration of Tetraiodophenolphthalein for Cholecystography. Radiology **5:** 211–214, September 1925.

14. ROWNTREE, L. G., HURWITZ, S. H., AND BLOOMFIELD, A. L.: Experimental and Clinical Study of the Value of Phenoltetrachlorphthalein as a Test for Liver Function. Bull. Johns Hopkins Hosp. **24:** 327–342, November 1913.

15. GRAHAM, E. A., COLE, W. H., COPHER, G. H., AND MOORE, S.: Simultaneous Cholecystography and Tests of Hepatic and Renal Functions by Single New Substance, Sodium Phenoltetraiodophthalein; Preliminary Report. J.A.M.A. **86:** 467–468, Feb. 13, 1926.

COLE, W. H., COPHER, G. H., AND GRAHAM, E. A.: Simultaneous Cholecystography and Determination of Hepatic Function. J.A.M.A. **90:** 1111–1113, April 7, 1928.

16. FRIED, B. M., AND WHITAKER, L. R.: The Effect of Liver Damage on Cholecystography in Dogs by the Use of Sodium Tetraiodophenolphthalein. Arch. Int. Med. **37:** 388–397, March 1926.

17. MOORE, S.: Personal communication.

18. AITKEN, L.: Personal communication.

19. LEVYN, L., AND AARON, A. H.: Cholecystography by the Oral Method. Radiology **6:** 204–212, March 1926.

20. LARIMORE, J. W.: Quoted by Graham *et al.* [In] Diseases of the Gall Bladder and Bile Ducts. Philadelphia, Lea and Febiger, 1928.

21. FANTUS, B.: Peroral Administration of Colloidal Contrast Medium in Cholecystography. J.A.M.A. **89:** 182–187, July 16, 1927.

22. SABATINI, G., AND MILANI, E.: Radiologic Visibility of the Gallbladder after Administration of Alkaline Bromides by Mouth. Internat. M. Digest. **7:** 259, 1925.

SUMMARIO IN INTERLINGUA

Aspectos Historic de Cholecystographia

Isto es un relation historic del discoperta del cholecystographia e de su disveloppamento initial, presentate como le Conferentia Carman ante le Societate Radiologic de America del Nord.

Le prime successose visualisation del vesica biliari esseva obtenite in le can in novembre 1923 post le injection de tetrabromphenolphthaleina de calcium. Iste mesme medio esseva etiam usate in le prime studios in humanos. Le prime successose cholecystogramma in un subjecto human esseva obtenite le 21 de februario 1924. Post le relation de iste successos initial, le autor procede a describer su continue experimentos con varie medios e methodos de introduction, le standardisation del technica, le problemas del toxicitate del medio, e le reactiones evocate per le medio.

The Importance of Cervical Myelography in Cervical and Upper Thoracic Nerve Root Avulsion[1]

WILLIAM JOSEPH VARLEY, M.D.[2]

INJURY TO THE brachial plexus is not uncommon. In infants it is seen as a birth palsy, usually involving the fifth and sixth cervical roots (5). In adults it occurs most frequently following trauma to the shoulder region in which stress traction has been placed on the involved roots. The term avulsion is reserved for intraspinal separation of the nerve root from the cord. Separation elsewhere as the result of blunt or closed trauma constitutes extraspinal or peripheral rupture (1, 5).

The mechanism of occurrence, clinical features, treatment, and myelographic findings in brachial plexus avulsion will be considered here and 3 cases will be reported.

MECHANISM OF INJURY

Barnes (2) gives an excellent discourse on the probable mechanism of brachial plexus injury. The head and shoulder are separated forcibly, the position of the arm determining the type of injury. When the arm is in adduction, the greater stress is placed on the upper roots (C-5 and C-6), resulting in an Erb type of paralysis. With the arm in various positions of abduction at the time of trauma, certain or all of the lower roots (C-7, C-8, or T-1) are injured and a Déjerine-Klumpke paralysis follows. This is less commonly observed in adults, probably because violent traction seldom occurs with the arm abducted. The severity of traction is of a degree sufficient to tear the cervical fascia and cause rupture of the overlying scalene musculature which protects the brachial plexus.

CLINICAL FEATURES

The clinical findings (1, 3–5, 7, 8, 10) depend upon the root or roots involved. The lesions are divided into those affecting C-5 and C-6 and those involving C-8 and T-1, with a combined type in which C-7 is added to either of the first two. Involvement of all the brachial plexus, C-5 to T-1, occasionally occurs.

In upper nerve root injury (Erb's paralysis), there is inability to abduct and rotate the arm, or to supinate the forearm. Pain may or may not be present; if present, it is often severe. The dorsal scapular nerve is involved, along with the long thoracic, the suprascapular, the lateral anterior thoracic, the axillary (circumflex), the musculocutaneous, and the phrenic nerves, and fibers of the lateral portion of the median nerve.

The arm is held in extension, internal rotation, pronation, and adduction. There is winging of the scapula, especially with the arm outstretched. Paralysis of the diaphragm may occur. These various findings are due to paralysis of the serratus anterior muscle, the rhomboids, the deltoid muscle, the teres minor, the infraspinatus, the supraspinatus, portions of the latissimus dorsi, the subscapularis, the subclavius, the brachialis, the biceps, the supinator, portions of the pectoralis major, the brachioradialis, the pronator, and several of the extensor and flexor groups of the forearm. The additional trauma to C-7 in either the upper or lower type of injury does little to change the clinical manifestations. Sensory changes are minimal and are usually confined to the shoulder region and outer aspect of the upper arm. They may, however, extend upward into the lateral portions of the neck when the roots of C-3 and C-4 happen to be involved (8). Sensory changes due to C-3 and C-4 root involvement are usually of a

[1] From the Department of Radiology, Mercy Hospital, Pittsburgh, Penna. Presented at the Forty-sixth Annual Meeting of the Radiological Society of North America, Cincinnati, Ohio, Dec. 4–9, 1960.

[2] Trainee of the National Cancer Institute, National Institutes of Health, United States Public Health Service.

transitory nature, sensation returning in a period of three to six months.

In the lower type of injury there are paralysis of the flexor and extensor muscles of the forearm and the intrinsic hand muscles and involvement of the triceps brachii. This is due to injury to the ulnar nerve, the medial portions of the median nerve, the radial nerve, and the medial anterior thoracic nerve. The sensory changes are in the medial aspect of the forearm and hand. Atrophy of muscles and vasomotor disturbances are more marked in this type of injury.

Involvement of the long thoracic nerve in Erb's paralysis and the presence of sympathetic nerve damage, manifested by Horner's syndrome, due to injury of T-1 in the Déjerine-Klumpke type indicate that the nerves are damaged before or soon after they leave the intervertebral foramina (4). Either of these complications has a poor prognosis and indicates an intraspinal (avulsion) lesion.

A complete avulsion of C-5, C-6, C-7, C-8, and T-1 results in paralysis of the muscles supplied by these nerve roots. There is complete loss of sensation in the arm and shoulder region, together with loss of deep reflexes and moderate atrophy of the entire limb. In practically all the injuries to the brachial plexus, the trauma is of such a nature as to cause unconsciousness for variable periods of time, from hours to days.

TREATMENT

Treatment of brachial plexus injuries in general concerns itself with preventing joint stiffness by means of passive exercise of the affected limb and prevention of muscle atrophy by galvanic stimulation of the muscles of the involved arm (2). If pain is severe, relief may be obtained by means of cervical sympathectomy or, in some instances, by amputation of the affected limb.

The decision regarding surgical intervention must of necessity depend upon the position of the lesion, *i.e.*, whether it is intraspinal or extraspinal. For an intraspinal lesion, laminectomy is the procedure of choice. This has been undertaken, however, only in the hope that a complete avulsion has not occurred and that suitable surgical maneuvers can be accomplished to restore physiologic function, partially or completely, to the affected nerve root (5, 6, 9).

It has been conclusively shown that laminectomy is of no value in avulsions of the brachial plexus roots (5, 6, 9). Myelography, in demonstrating the presence or absence of avulsion, thereby assumes considerable importance in overall management. In those cases in which an avulsion is shown myelographically, conservative therapy with general care of the affected arm and later reconstructive surgery are indicated (1, 3, 4, 7, 9).

In extraspinal injury where myelography is negative, it may be possible to institute repair by primary suturing at the site of injury, or by resection of the damaged portion of the nerve and anastomosis of the free nerve ends, with or without suitable autografts (2).

MYELOGRAPHIC FINDINGS

Myelography in avulsion of a brachial plexus root displays a diverticulous outpocketing of the opacified intrathecal space (1, 3, 4, 6, 7, 9, 10). The term "traumatic meningocele," adopted by Murphey *et al.* (3), has been proved by White and Hanelin (4) to explain the mechanism of this outpouching. The latter authors state: "When roots of the brachial plexus are avulsed, a cuff of dura-arachnoid is torn out of the spinal theca. With retraction and shrinkage of the severed stump, a cavity is created which fills with spinal fluid. It is gradually closed by reformation of the ruptured arachnoid and dura, and a traumatic meningocele is formed."

Demonstration of the meningocele, coupled with the appropriate clinical picture, is to be considered pathognomonic of a brachial plexus root avulsion. The size and configuration of the meningocele are dependent upon the force of the exciting trauma.

Fig. 1. Case I. Anteroposterior roentgenograms showing an avulsion of the cervical and upper thoracic nerve roots at the levels of C-5 through T-1 on the left side.

A. The upper arrow designates the less easily recognized abnormality, obliteration of the nerve sleeve. This is a result of healing of the previously torn dura.

B. The lower arrows point to the more commonly observed abnormalities. Note the large outpouching at the C-7 level, an indication of the severity of the trauma.

Two types of abnormality are seen in a cervical myelogram that demonstrates brachial plexus avulsion (9). The more dramatic and more easily recognized is characterized by extradural collections of opaque material in pockets lateral to the opacified intrathecal space. These collections are the aforementioned traumatic meningoceles. In the other type, the abnormality is not as easily identified and is manifest only as an obliteration of the root sleeves. This appearance is a result of healing of the previously torn dura and is encountered only in those cases in which myelography was delayed for some time after the original injury.

Failure of myelography to disclose a surgically proved brachial root avulsion has been said to be due to an associated protruding disk or absence of tear in the meninges (4).

Myelographic demonstration of a brachial root plexus avulsion can be performed early, even before localizing neurologic signs are present. The procedure is done with relative ease and safety to the patient.

CASE REPORTS

CASE I: R. K., a 16-year-old white male, was injured in January 1959, when his sled struck a car. He was unconscious on admission to the hospital. When consciousness returned, he was unable to move his left arm, which was numb throughout. This situation persisted, and six months later, on June 29, he was admitted to the Mercy Hospital (Pittsburgh, Penna).

The physical examination was entirely negative except for the findings referable to the left arm, which was completely paralyzed. Atrophy of the muscles was present from the deltoid and scapularis muscles down to the flexors and extensors of the hand. There was complete anesthesia to pain and light touch to the level of the insertion of the pectoral muscles. The deep reflexes were absent and there was no co-ordination.

A myelogram (Fig. 1), obtained on July 3, showed a complete avulsion of C-5 through T-1. In view of this discovery, coupled with the physical findings, surgical intervention was not considered. The patient was placed in an airplane splint and discharged to be followed as an outpatient.

CASE II: D. S., a 19-year-old white male, was injured in an automobile accident in May 1957. He was unconscious for ten days, then awoke with paralysis of the left leg and left arm and shoulder. Motion returned to the left leg after a month, but paralysis persisted in the arm, though later there was some return of motion in the left shoulder and in the fingers.

There was numbness in the left side of the neck, shoulder and arm, with return of sensation to the left side of the neck and in part to the forearm after a vague period of time. Pain, however, persisted in the hand and forearm.

Physical examination at the Mercy Hospital in mid-December revealed a healed laceration of the left eyebrow, left side of the neck, and the left forearm. A prominence over the left clavicle laterally was believed due to a healing fracture of that bone. A large hematoma was present in the left axilla and multiple pigmented areas were seen over the left forearm and hand. The left hand was held in a claw-like manner. Absence of perspiration in the left axilla suggested sympathetic nerve involvement.

The only movement in the shoulder girdle was related to a still functioning trapezius muscle. There was atrophy of the deltoid muscle, the biceps, triceps, pectoralis, rhomboids, latissimus dorsi, serratus anterior, the supra- and infrascapu-

lar muscles, as well as of muscles of the forearm and hand except for the thenar group. No motion was present in the elbow. Flexion was absent in the wrist and extension was limited. Slight flexion and extension remained in the terminal phalanges. Abduction, adduction, and flexion of the thumb persisted to a slight degree.

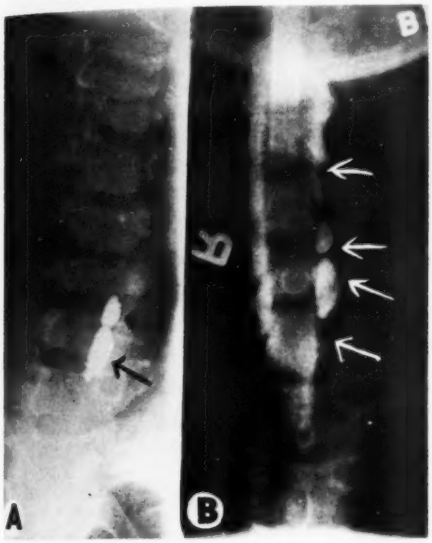


Fig. 2. Case II. Anteroposterior roentgenograms showing an avulsion of the nerve roots at C-6 through T-1 levels on the left side.

A. Residual contrast material in the traumatic meningoceles at the levels of C-7 and C-8.

B. An example of both types of abnormality seen in avulsion of the nerve roots. The uppermost arrow designates the obliteration of the root sleeve, and the lower arrows the diverticular outpouching more commonly seen.

There was anesthesia to pin prick over the distribution of the dermatomes of C-5 to T-1. The deep reflexes were absent in the upper arm.

A myelogram obtained Dec. 18 (Fig. 2) showed an avulsion of the brachial plexus roots of C-6, C-7, C-8, and T-1. On the basis of these findings and the physical signs, it was felt that nothing could be done surgically for this patient. He was discharged for further follow-up as an outpatient.

CASE III: E. P., a 60-year-old white male, was involved in an accident at his work four weeks prior to his admission to Mercy Hospital on March 28, 1955. The right arm had been caught in a roller and belt on a coal tipple and pulled into the machine up to the shoulder before the machine could be stopped. An open reduction for a humeral shaft fracture was performed in another institution.

The patient complained of motor and sensory loss in the right arm since the time of the accident. In addition, the shoulder ached from the "dead

Fig. 3. Case III. Two roentgenograms in the anteroposterior position, showing an avulsion of the nerve roots of C-7, C-8, and T-1. This is an example of the Déjerine-Klumpke type of nerve root avulsion on the right side.

weight" of the arm. He had noticed drooping of the right eyelid and diminished visual acuity in the right eye. He also complained of weakness in the right leg and an unsteadiness during standing or walking.

Physical examination showed a Horner's syndrome on the right and a complete motor and sensory loss in the right arm, with absence of its deep reflexes. The entire arm appeared red and swollen, with a scar from the open-reduction procedure. The patient walked with a spastic gait, and the deep reflexes in the lower extremities were hyperactive.

The clinical impression was an avulsion of the brachial plexus, complete in type (C-5 through T-1), and associated involvement of the pyramidal tracts to the lower extremity.

Myelography, performed on April 5 (Fig. 3), demonstrated a complete avulsion of the nerve roots of C-7, C-8, and T-1. These findings are typical of the lower or Déjerine-Klumpke type of paralysis, and surgical intervention was not contemplated. Incidentally, the myelographic findings are seen to differ from the neurologic impression of a *complete* avulsion. A sling to support the weight of the injured arm was advised, and the patient was discharged on April 7, to be followed as an outpatient.

SUMMARY

Injury to the brachial plexus in adults is a result of forceful trauma to the shoulder region. Severe traction placed

on the nerve roots can result in their avulsion from the spinal cord. The clinical manifestations are dependent upon the roots involved. The mechanics of the injury are discussed in detail. The dramatic myelographic findings and the pathologic changes causing them are described.

The importance of myelography in brachial plexus injuries in relation to the management of the patient is stressed. It may permit an early accurate diagnosis before definite localizing neurologic signs are apparent. In addition, it may be used in determining the most practical surgical maneuver to hasten the return to use of the injured extremity in whole or in part. If complete avulsion of the nerve roots is demonstrated by cervical myelography, therapy should be directed toward general care of the arm instead of surgical intervention in the form of laminectomy.

1400 Locust St.
Pittsburgh 19, Penna.

REFERENCES

1. RAYLE, A. A., JR., GAY, B. B., JR., AND MEADORS, J. T.: The Myelogram in Avulsion of the Brachial Plexus. Radiology **65**: 65–71, July 1955.
2. BARNES, R.: Traction Injuries of the Brachial Plexus in Adults. J. Bone & Joint Surg. **31-B**: 10–16, February 1949.
3. MURPHEY, F., HARTUNG, W., AND KIRKLIN, J. W.: Myelographic Demonstration of Avulsing Injury of the Brachial Plexus. Am. J. Roentgenol. **58**: 102–105, July 1947.
4. WHITE, J. C., AND HANELIN, J.: Meylographic Sign of Brachial Plexus Avulsion. J. Bone & Joint Surg. **36-A**: 113–118, January 1954.
5. TARLOV, I. M., AND DAY, R.: Myelography to Help Localize Traction Lesions of the Brachial Plexus. Am. J. Surg. **88**: 266–271, August 1954.
6. JAEGER, R., AND WHITELEY, W. H.: Avulsion of the Brachial Plexus. Report of Six Cases. J.A.M.A. **153**: 633–635, Oct. 17, 1953.
7. MENDELSOHN, R. A., WEINER, I. H., AND KEEGAN, J. M.: Myelographic Demonstration of Brachial Plexus Root Avulsion. Arch. Surg. **75**: 102–107, July 1957.
8. KERR, A. S.: Cervical Plexus Injuries as Extension of Brachial Plexus Injuries. J. Bone & Joint Surg. **31-B**: 37–39, February 1949.
9. WHITELEATHER, J. E.: Roentgen Demonstration of Cervical Nerve Root Avulsion. Am. J. Roentgenol. **72**: 1017–1022, December 1954.
10. SHAPIRO, R., AND ROBINSON, F.: Cervicodorsal Diverticula of the Subarachnoid Space. Radiology **73**: 776–778, November 1959.

SUMMARIO IN INTERLINGUA

La Importantia de Myelographia Cervical in Avulsion de Radice Nerval Cervical e Supero-Thoracic

Injurias del plexo brachial in adultos es le resultato de trauma fortiate in le region del spalda. Avulsion del radices nerval ab le medulla spinal pote resultar de traction sever. Le mechanica de tal injurias es discutite in detalio. Le manifestationes clinic es describite con referentias al radices nerval particular interessate. Si le radices nerval a C-5 e C-6 es separate, le paralyse de Erb resulta, sed si le disruption affice C-8 e T-1, le paralyse es del typo Dejerine-Klumpke.

Myelographia in casos de injuria del plexo brachial es importante pro le diagnose, le prognose, e le therapia. In avulsion de un radice de plexo brachial, le constatation significative es un extrusion diverticular del opacificate spatio intrathecal ("meningocele traumatic"). A vices le myelogramma permitte un precoce diagnose accurate ante que definite localisante signos neurologic es manifeste. In casos in que le myelogramma indica un avulsion complete, le prognose es pauco favorabile.

In plus, myelographia pote esser usate pro determinar le manovra chirurgic que es le plus practic pro expedir le retorno del extremitate injuriate al uso total o al minus partial. Si le complete avulsion del radices de nervo es demonstrate, le therapia debe visar al sollicitude general del bracio e non a un intervention chirurgic in le forma de laminectomia.

Spinal Cord Tumors[1]

G. LOMBARDI, M.D., and A. PASSERINI, M.D.

UP TO THE end of 1959, 244 patients, with a total of 249 spinal tumors, had undergone surgery in the Neurologic Institute of Milan (Istituto neurologico di Milano, Italy). The growths were examined histologically, with the exception of 19 endomedullary gliomas, in which decompression was carried out, but no biopsy was done. From this series, we have excluded the cases of medullary compression consequent upon primary or metastatic vertebral tumors, corresponding to 64.2 per cent of the whole series. Meningiomas predominated here, with 65 cases, followed by 37 neurofibromas, 29 malignant extradural tumors, and 21 gliomas. There were 42 tumors (17.2 per cent) in the *cervical spine:* 20 neurofibromas and 12 intramedullary tumors. The *lumbar spine* was the site of 41 tumors (17 per cent), of which 19 were ependymomas and 16 neurofibromas. Four *sacral* tumors were recorded (1.6 per cent). In the 557 cases reported by

TABLE I: PATHOLOGY AND LOCATION OF 249 SPINAL CORD TUMORS IN 244 PATIENTS

Tumors	Intradural	Extradural	Intramedullary	Intra-Extradural	Total
Neurofibroma*	52	4	..	18	74
Meningioma†	65	3	..	3	71
Ependymoma	21	..	14	..	35
Metastases	..	15	1	..	16
Sarcoma	..	9	..	..	9
Lipoma	3	4	..	..	7
Neurofibromatosis	..	..	..	6	6
Lymphosarcoma	..	4	..	..	4
Plasmacytoma	..	2	..	..	2
Ganglioneuroma	..	1	..	..	1
Hemangioblastoma	1	..	..	..	1
Epidermoid	1	..	..	..	1
Dermoid	..	..	1	..	1
Astrocytoma	..	..	1	..	1
Spongioblastoma	..	..	1	..	1
Gliomas (unclassified)	..	..	19	..	19
TOTAL	143 (57%)	42 (17%)	37 (15%)	27 (11%)	249 (100%)

* One patient with 2 tumors and one with 3.
† Two patients with 2 tumors.

as well as angiomas of the spinal cord, since these are vascular malformations. In our material, the frequency of the latter (21 examples) among the total of spinal tumors was over 8 per cent, more than twice the figures given by Wyburn-Mason (23) and by Therkelsen (18).

Spinal tumors occurred about equally in the two sexes: 128 in men and 116 in women. If 6 cases of Recklinghausen's neurofibromatosis in which the medullary involvement was generalized are excluded, the remaining 243 tumors were distributed as follows: The *thoracic spine* was the most frequent site with 156 tumors, Rasmussen, Kernohan and Adson (17) and the 296 cases reported by Elsberg (6), approximately the same distribution was noted.

In Table I, the tumors have been listed according to their nature and their position relative to the cord and the membranes. There are 4 groups:

(*a*) *Intradural tumors* comprised the largest group, numbering 143 (57 per cent). The majority were meningiomas, neurofibromas, and ependymomas. Bony changes could be observed in 38 cases (26 per cent).

(*b*) *Extradural tumors* numbered 42 (17

[1] From Istituto neurologico di Milano, Milan, Italy. Accepted for publication in September 1960.

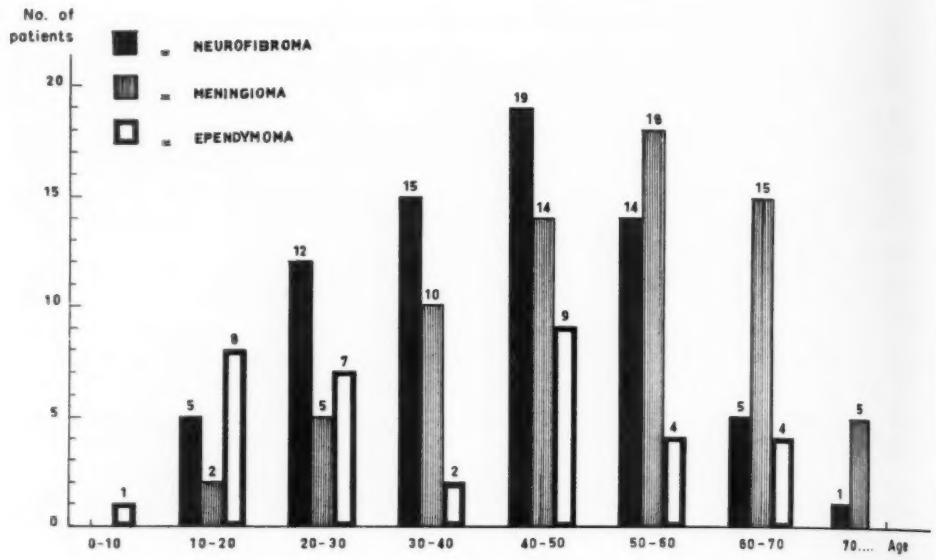


Diagram 1

per cent), of which 29 were malignant neoplasms, either primary or metastatic from more distant, known or unknown primary localizations (Fig. 1). A rather curious finding was that none of these extradural tumors was localized in the cervical region; 36 were found in the thoracic spine. Signs of bone involvement were encountered in 24 cases (57 per cent).

(*c*) *Intramedullary tumors* were 37 in number (15 per cent). Nineteen gliomas formed the largest group. These were treated operatively but not examined histologically. The second largest group consisted of 14 ependymomas (Fig. 2). Signs of bone involvement were present in 13 cases (35 per cent).

(*d*) *Intra-extradural tumors* (11 per cent) included 3 meningiomas, 2 of which were malignant; 6 cases of Recklinghausen's disease; 18 neurinomas, mostly of the dumbbell type. In this group, 20 cases (74 per cent) showed evidence of bone involvement.

Among the total of 249 spinal tumors 95 (38 per cent) produced changes on the ordinary film. Camp (4) and Tönnis (19) have reported a frequency of approximately 30 per cent. Spinal tumors, as a whole, form a rather heterogeneous group, not very suitable for statistical radiological analysis. This procedure may be applied, however, to the main groups: meningiomas, neurofibromas, ependymomas, and multiple tumors.

NEUROFIBROMAS

Seventy-four neurofibromas were seen in 71 patients, of whom 1 had 2 tumors and 1 had 3. These tumors constitute the largest single group in our material, and their relative frequency (29.7 per cent) corresponds almost identically with the frequency reported by Woltman, Kernohan, Adson, and Craig (22) among 979 spinal tumors seen in the Mayo Clinic (29.9 per cent). A comparison made of neurofibromas of the acoustic nerve oper-

TABLE II: NEUROFIBROMAS

Location	No. of Cases	Dumbbell Tumors	Bone Changes
Cervical	20	11	9
Thoracic	37	10	13
Lumbar	16	2	6
Sacral	1	..	..
TOTAL	74	23 (31 per cent)	28 (38 per cent)

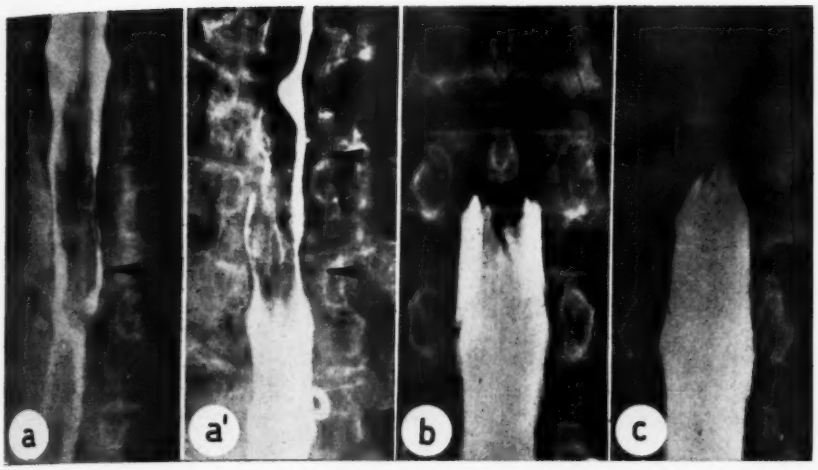


Fig. 1. Extradural tumors. *a* and *a'*. Plasmacytoma. The clearly outlined spinal cord is displaced laterally. *b* and *c*. Metastases.

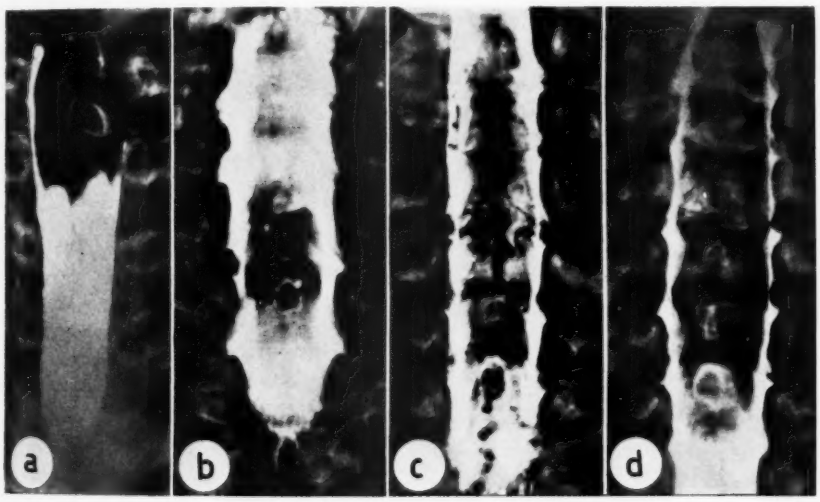


Fig. 2. Intramedullary tumors. *a*. Dermoid tumor with spina bifida. *b*. Ependymoma. *c*. Astrocytoma. *d*. Unclassified glioma.

ated on during the same period (111 cases) demonstrated a ratio of 1:1.5.

Neurofibromas may develop at any age. Our youngest patient was fourteen, and our oldest seventy-five. As can be seen in Diagram 1, the third, fourth, and fifth decades are the periods of highest frequency. The average age of our 71 patients at the time of operation was forty-one years.

In contrast to other statistical studies, indicating an almost equal distribution between the sexes, our material showed a distinct predominance of males (44 male as against 27 females). The tumors were diffusely distributed along the whole length of the spinal column and showed no particular preference for any site (Figs. 3 and 4), although, as other authors have also mentioned (2, 19), they were not found at the level of the first cervical root.

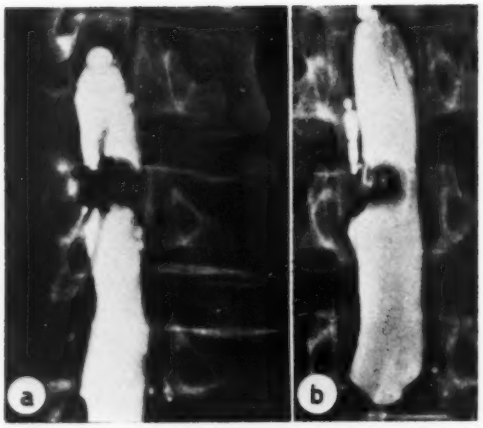


Fig. 3. Intradural neurofibromas.

(Fig. 4). This disproportion is caused by an asymmetrical development of the dumbbell tumor; the intraspinal part may be relatively small, whereas the extraspinal portion may grow to a considerable size.

Erosion and decalcification of the pedicle in contact with the neurinoma is a less frequent and less typical sign than that mentioned above. As a rule, this type of lesion is limited to one vertebra, but two neurofibromas grew to such size that they eroded 3 pedicles and brought about an excavation of the posterior surfaces of several vertebral bodies. The frequency of the bony lesions observed by Buchstein (1) and by Bull (2) was 45 per cent.

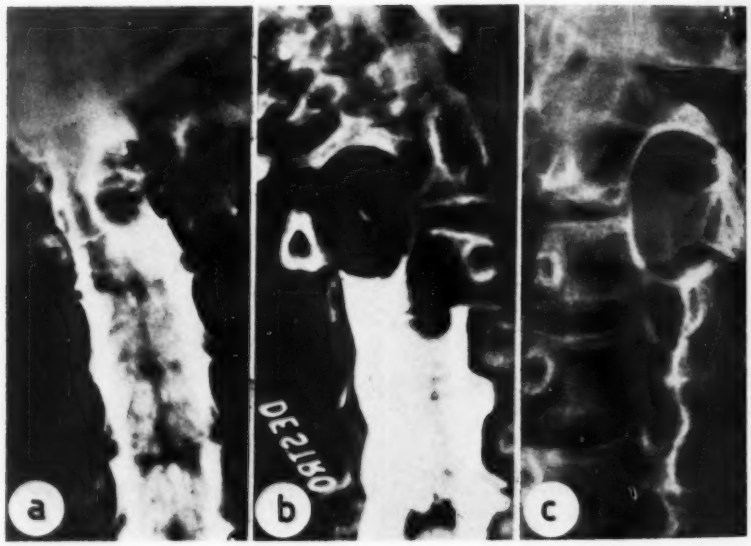


Fig. 4. Neurofibromas at the level of C2-C3. *a*. Intradural tumor with no osseous changes. *b* and *c*. Dumbbell tumors.

Of the 74 neurofibromas, 28 (38 per cent) produced changes on the ordinary film, and in the dumbbell type of tumor, such changes were found particularly often; in fact, in 16 out of the 23 cases forming this group, an enlarged intervertebral foramen was seen. The most pronounced widening was found at the level of the second and third cervical vertebrae in patients with neurological signs and symptoms which were not always in proportion to the bony changes

At operation the walls of two tumors were found to contain calcifications that had been invisible on the radiographs.

MENINGIOMAS

Seventy-one meningiomas were observed in 69 patients, 2 of whom had 2 tumors each (Fig. 5). In our total series, this type of tumor accounted for 28.5 per cent, a figure only slightly higher than the 25.9 per cent mentioned by Woltman *et al.* A comparison with the cranial

meningiomas operated on during the same period (391 cases) demonstrated a ratio of 1:5.5. As can be seen in Diagram 1, these are tumors of the adult period, with a distinctly higher incidence in the fifth, sixth, and seventh decades. The average age of the patients at the time of operation was forty-nine years; the youngest patient was fifteen and the oldest seventy-three, only 5 patients being below the age of thirty. In our material, also, the preponderance of women was great: 55 females to 16 males. The thoracic region was by far the most frequently affected, being the site of 92 per cent of the tumors (65 cases). This information may not be of a radiologic nature, but it is helpful, nevertheless, in making a diagnosis.

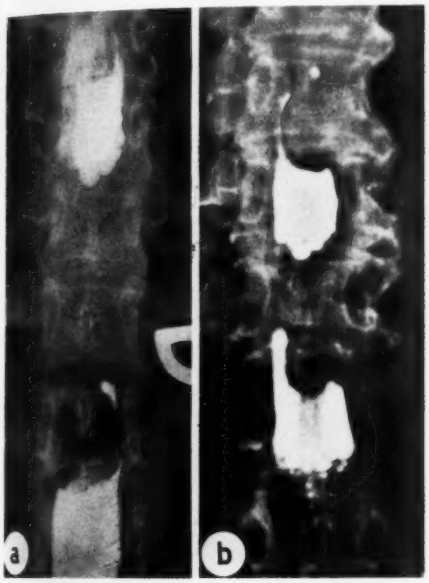


Fig. 5. Multiple meningiomas. In each case 2 tumors are clearly demonstrated by myelography.

TABLE III: MENINGIOMAS

Location	No. of Cases	Bone Changes	Calcifications Seen on Film
Cervical	6	..	..
Thoracic	65	9	3
Lumbar	..	..	..
TOTAL	71	9 (12 per cent)	3

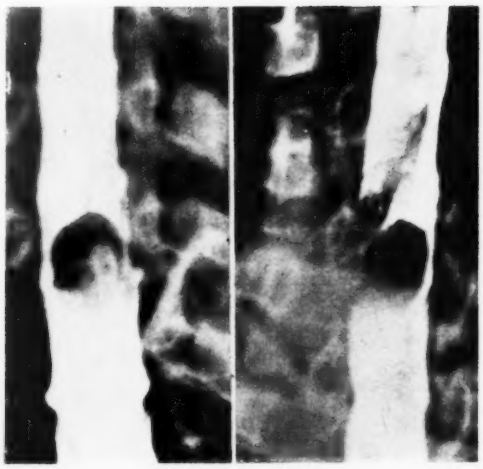


Fig. 6. Meningioma.

As a rule, meningiomas are not very large (Fig. 6) in comparison with neurofibromas, but we saw 2 that were 6 and 8 cm. long, respectively. Of all the intradural meningiomas, 56 (87 per cent) were implanted on one of the lateral surfaces of the dura; in 4 patients, the tumor was of posterior localization exclusively, and in 5 it was exclusively anterior. The last-mentioned site, of course, may cause considerable difficulty at surgery.

Bony changes were observed 9 times (12 per cent), a figure that is slightly higher than the 10 per cent reported by Buchstein (1), Bull (2), and Camp (3). These changes usually consist of erosion and decalcification of the pedicle which is in contact with the tumor; in only 2 cases were 2 pedicles affected. In one instance a malignant extradural meningioma had widened an intervertebral foramen, a finding never observed in any other case of meningioma.

Calcifications are often found in these tumors. They were present in 41 cases (73 per cent) in a continuous series of 56 histological examinations in which they were specifically sought for. At operation, it was found that the root of the tumor was calcified and/or ossified in 10 cases, but in only 3 of these had it been visible on the films.

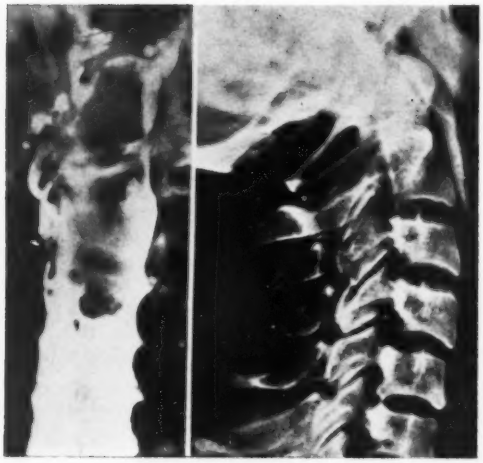


Fig. 7. Ependymoma with uncommon deformation of the posterior arches of the atlas.

EPENDYMOMAS

There were 35 ependymomas, representing 14 per cent of our material. The ratio of these tumors to the number of cerebral ependymomas operated upon in the same period (118 cases) was 1:3. Ependymomas occur in patients of any age. The youngest of our series was a child of six, the oldest a man of sixty-three (Diagram 1). The average age at time of surgery was thirty-four years. Males were more often affected than females (20 and 15 cases respectively). This is in agreement with the report of Woltman *et al.*, although in their material females were better represented.

TABLE IV: EPENDYMOMAS

Location	No. of Cases	Bone Changes
Cervical	4	1
Thoracic	7	2
Conus medullaris	12	10
Filum terminale	12	9
TOTAL	35	22 (62.85 per cent)

The ependymoma may develop at any level along the spinal cord, but has a distinct preference for the caudal portion. It represents 68 per cent of all tumors of the conus medullaris, according to Kernohan *et al.* (14), and is even more frequent in the filum terminale, probably because of the ependymal origin of this structure. The distribution of these 35 cases is shown in Table IV.

In 22 of our 35 cases (62.85 per cent), there were bony changes. The lesions were limited to one vertebra in 3 patients, while in all others 2 or more vertebrae were affected. In only 1 case was the erosion of the pedicles exclusively unilateral; in all the others it was bilateral. In 10 patients the posterior surface of 1 or more vertebral bodies was excavated, particularly in its central part, owing to the resistance of the disks to erosion. Bone lesions are rare in cases with cervical and thoracic localization, but are frequent and severe in association with tumors of the conus medullaris and the filum terminale, where ependymomas at times grow to exceptional size. In the case reported by Horrax and Henderson (12), the tumor had affected the whole of the cord. In 3 of our own patients, the neoplasm extended from the ninth, eleventh, and twelfth thoracic vertebrae, respectively, to the sacrum.

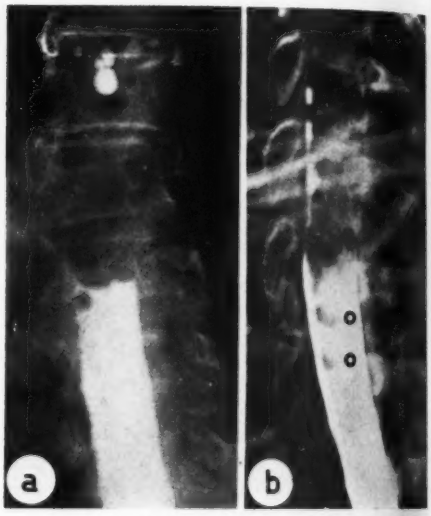


Fig. 8. Multiple neurofibromas (see text).

Among the total of 24 tumors of distal localization, 19 (79 per cent) presented direct radiological changes. One intradural ependymoma, which extended from

the third cervical vertebra into the posterior fossa, had caused thinning of the laminae and of the posterior arch of the atlas, which is a rather uncommon finding (Fig. 7).

MULTIPLE TUMORS

In our series, the multiple-tumor group was represented by 2 patients with neurofibromas, 2 with meningiomas, and 6 with the neurofibromatosis of Recklinghausen. In all, there were 10 cases, or precisely the 4 per cent reported by Camp (5). In the first of the patients with neurofibroma, there was a second nodule hanging from the same root as the principal tumor (Fig. 8,a). In the second of these patients, near the lower pole of the largest tumor, 2 more growths were found (Fig. 8,b). In each of 2 patients, 2 thoracic meningiomas could be clearly demonstrated by myelography (Fig. 5). Our material contained no instance of association of meningioma with neurinoma or other tumors.

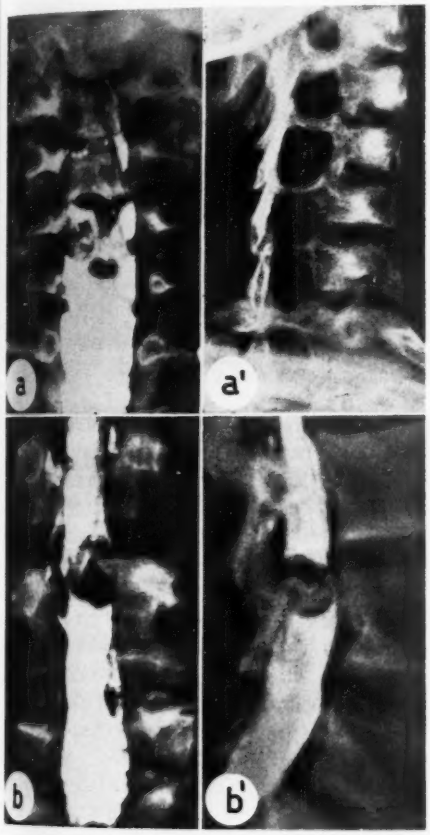


Fig. 9. Neurofibromatosis. *a*. Complete block at the cervical region with marked widening (*a'*) of several intervertebral foramina. *b* and *b'*. Same case with osseous changes and curvilinear defect at the lumbar region.

Fig. 10. Neurofibromatosis. Multiple intra- and extradural defects, with osseous changes in the cervical canal.

In the 6 cases of Recklinghausen's disease, the tumor nodules were disseminated, the density varying from case to case along the whole of the spinal cord, with evident predilection for the cervical and lumbar regions. The multiplicity of the bony changes and of the myelographically demonstrated defects in various sites, and the irregular distribution of the tumor nodules in the intra- and extradural spaces are typical signs of this disease (Figs. 9 and 10).

DISCUSSION

Bone involvement: In 95 (38 per cent) of 249 cases of spinal cord tumors there were bone changes, the formation of

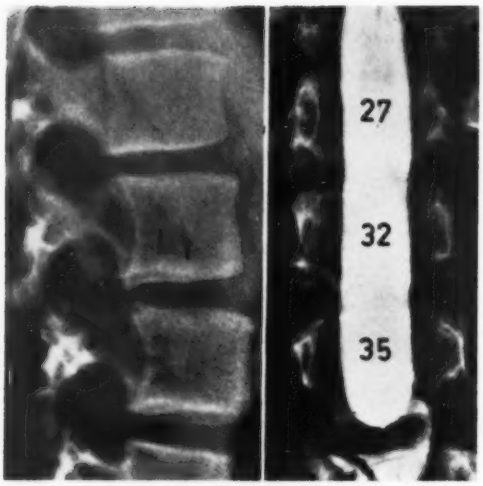


Fig. 11. Enlargement of the spinal canal (interpeduncular distance in millimeters) with normal myelogram. Surgery revealed no other abnormalities either inside or outside the dural sac.

which depends on several factors: the type and size of tumor and its level and position relative to the spinal column and the spinal cord and its coverings. As already stated, the growths that most often cause lesions of the bone are those with a simultaneous intra- and extradural development (74 per cent). These tumors are mostly of the "dumbbell" type which enlarge one (Fig. 4,b and c) or more intervertebral foramina (Fig. 9,a). The severity of the bone lesion does not constitute an indication of the degree of involvement of the cord, as the dumbbell tumors never develop symmetrically.

Next in order of frequency of bone involvement were the extradural tumors which are often malignant. These affect the vertebrae in 57 per cent of the cases. Their characteristic feature is absence of any clearly defined erosion of the bone. The outlines of the pedicles are vague and indefinable and they are seen to fade away by degrees. The diagnosis is rather difficult in the early stage, especially in senile spinal columns and in those with an altered trophism, but is easily made in the presence of multiple clearly osteolytic lesions, *i.e.*, in cases such as we have excluded from the present series.

The signs of bone involvement in 35 per cent of the cases of endomedullary tumors consist in enlargement of the vertebral canal, to various degrees of width, in all directions.

The intradural tumors constitute the largest group, with 26 per cent showing bone changes. We must consider separately the bone lesions caused by meningiomas and neurinomas and by ependymomas of the conus and of the filum terminale. The first mentioned lesions are, as a rule, limited to the pedicle or to the intervertebral foramen adjoining the tumor. Only 2 neurinomas had eroded several pedicles and excavated the posterior surface of the vertebral bodies. Such alterations, on the other hand, occur frequently in cases of ependymoma. The malformative nature of certain tumors is at times indicated by spina bifida, as we saw in 1 case each of endodural lipoma and intramedullary dermoid tumor (Fig. 2,a).

In examination of a spinal column for a suspected tumor, the possibility of bone lesions in different, even distant, sites must not be forgotten. The method of Elsberg and Dyke (7), according to which the diagnosis is based on measurement of the interpeduncular distance, is reliable when other bone changes are present but in their absence, it is not satisfactory. Camp (3), Hannan, Hughes, and Mulvey (10), and others (19) found that alterations of the pedicles are of greater importance, and this is our experience also. Jefferson (13) mentions that the Elsberg-Dyke method may be misleading in those cases of large spinal canals, probably of a malformative nature, without alterations of the cord, the meninges, or the peridural tissue. We observed 3 such cases. The first was subjected to operation in spite of a negative myelogram (Fig. 11), because the neurological findings indicated a lesion of the cord at the same level as the bone lesion. Surgery revealed a wide vertebral canal but no other abnormalities either inside or outside the dural sac.

There is no doubt that spinal cord

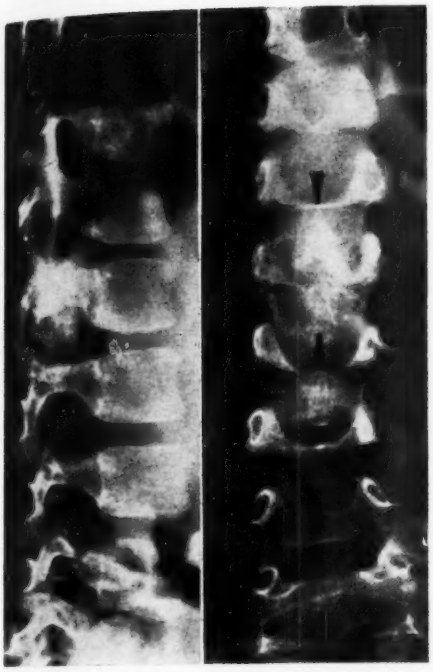


Fig. 12. Extradural ganglioneuroma with calcifications and osseous changes.

tumors are the most frequent cause of widening of the spinal canal, but they are not the only one. Other pathological conditions, not of a tumoral nature, can give the same appearance. These disorders form a rather heterogeneous group, including the well known extradural spinal cysts and many other less common lesions, as multiple aneurysms of the spinal cord arteries (15), angiomas of the spinal cord (8, 16), diastematomyelia (11), hydromyelia (20), and other anomalies of the cord (21), among which occult meningoceles must also be included. All of the abnormalities mentioned above have one factor in common, *i.e.*, they exert a constant pressure on the vertebrae over a long period.

Calcification: The deposition of calcium salts is of rather frequent occurrence only in cases of meningioma (73 per cent); in other tumors it is rare. During operation, calcification was encountered in 10 meningiomas, in 2 neurofibromas, in 1 ependymoma, and in 1 ganglioneuroma.

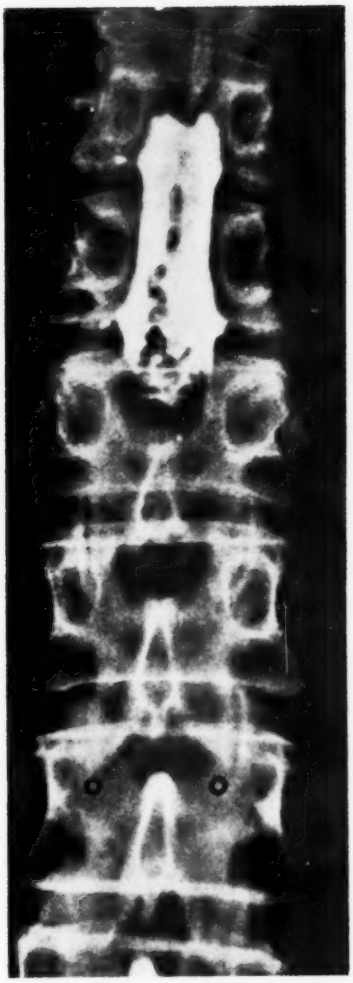


Fig. 13. Giant ependymoma with marked tortuosity and dilatation of the spinal cord veins above the obstruction; osseous changes at the second lumbar vertebra only (○).

Regardless of its actual frequency, it is seldom observed radiologically, even with tomography (2, 9). We were able to demonstrate it in only 3 cases of meningioma, and in 1 of ganglioneuroma (Fig. 12): *i.e.*, in less than 2 per cent of the cases in this series. On the other hand, calcification is not pathognomonic of tumor. We have recently observed it on the radiographs of a case of posttraumatic epiduritis and 1 of dorsal radicular cysts.

Myelography: Since direct signs of tumor are present in only 38 per cent of the cases, it is clear that in at least the other 62 per cent, though actually in a much higher percentage, the question of a myelographic diagnosis does arise. In this connection we do not wish to discuss the advantages or disadvantages of various positive and negative contrast media. Since the advocates of each type of myelography have expressed the accuracy of their preferred type in terms of percentages, it is important to define the term "accuracy." If it means finding the level of the tumor, then myelography with iodized oil, if carried out with a perfect technic, is accurate in almost 100 per cent of the cases. If, on the other hand, it means establishing a diagnosis of the nature of the growth, or of its position relative to the cord and its membranes, then the accuracy is much lower.

The majority of our own patients were examined with iodized oil; only during the past year have we employed gaseous contrast medium. It is our opinion that the images obtained with positive contrast material are much more demonstrative and richer in detail than those with air.

It is our practice to carry out myelography in cases of suspected tumors whether or not there are bone changes, and even at sites which conflict with, or only partially agree with, the clinical data. Rather large tumors may give rise to no sign of bone involvement, or only to slight signs, as for instance, the case of ependymoma shown in Figure 13. The myelographic appearance of the tumors and nontumoral disorders of the spine has been described in detail by Camp (4, 5) and by Epstein (8), and there is no need for further recapitulation here. When possible, myelography should be extended to the whole of the spinal cord, so as to exclude the presence of other tumors, found in 4 per cent of our material, and of other pathological conditions.

The most frequent association is that of herniated disk. We also saw a neurinoma associated with an angioma of the spinal cord, and a neurinoma of the first thoracic root, clinically unsuspected, in which

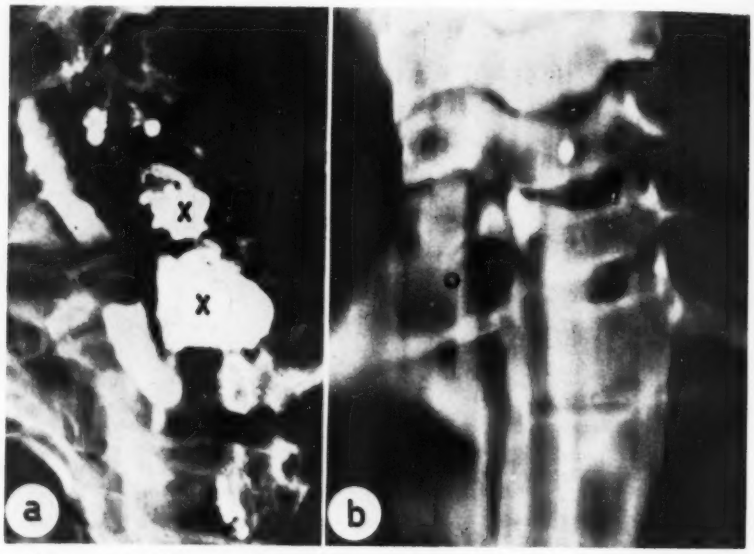


Fig. 14. Dumbbell neurofibroma with round defect at myelography and with marked widening of the intervertebral foramina (○). Large extradural sacculation (X) at the seventh and eighth foramina of the opposite side.

myelography showed a large extradural sacculation of the opposite side (Fig. 14).

SUMMARY

Of 249 spinal tumors, 95 (38 per cent) produced bone changes and 4 (2 per cent) caused calcifications that were radiologically visible. The neoplasms in the majority of the cases were in the thoracic region (64.2 per cent), the other sites being, in the order of frequency, (*a*) the cervical (17.2 per cent), (*b*) the lumbar (17 per cent), and (*c*) the sacral regions (1.6 per cent). Fifty-seven per cent of the tumors were intradural, 17 per cent extradural, 15 per cent intramedullary, and 11 per cent intra-extradural.

The frequency of bone changes was 74 per cent in the intra-extradural tumors, 57 per cent in the extradural tumors, 35 per cent in the intramedullary, and 26 per cent in the intradural tumors.

In 4 per cent of the cases, multiple tumors were encountered.

The direct radiologic and myelographic findings seen in spinal tumors, in particular those of neurofibromas, meningiomas, ependymomas, and multiple tumors, are discussed and critically assessed.

Istituto Neurologico di Milano
Via Celoria 11
Milano, Italy

REFERENCES

1. BUCHSTEIN, H. F.: Meningiomas of the Spinal Cord. Minnesota Med. **24:** 538–545, July 1941. (Quoted by Epstein, 8).

2. BULL, J. W. D.: Spinal Meningiomas and Neurofibromas. Acta radiol. **40:** 283–300, August–September 1953.

3. CAMP, J. D.: Roentgenologic Localization of Tumors Affecting the Spinal Cord. Am. J. Roentgenol. **40:** 540–544, October 1938.

4. CAMP, J. D.: Contrast Myelography. M. Clin. North America **25:** 1067–1102, July 1941.

5. CAMP, J. D.: Contrast Myelography Past and Present (Carman Lecture). Radiology **54:** 477–505, April 1950.

6. ELSBERG, C. A.: Surgical Diseases of the Spinal Cord, Membranes and Nerve Roots. New York, Paul B. Hoeber, Inc., 1941.

7. ELSBERG, C. A., AND DYKE, C. G.: Diagnosis and Localization of Tumors of the Spinal Cord by Means of Measurements Made on X-ray Films of Vertebrae, and Correlation of Clinical and X-Ray Findings. Bull. Neurol. Inst., New York **3:** 359–394, March 1934.

8. EPSTEIN, B. S.: The Spine: A Radiological Text and Atlas. Philadelphia, Lea & Febiger, 1955. (Extensive bibliography)

9. GRAY, E. D.: Calcification and Ossification of Spinal Tumours. Brit. J. Radiol. **15:** 365–369, December 1942.

10. HANNAN, J. R., HUGHES, C. R., AND MULVEY, B. E.: Spinal Cord Tumors. Radiology **53:** 711–719, November 1949.

11. HERREN, R. Y., AND EDWARDS, J. E.: Diplomyelia (Duplication of the Spinal Cord). Arch. Path. **30:** 1203–1214, December 1940. (Quoted by Jefferson, 13).

12. HORRAX, G., AND HENDERSON, D. G.: Encapsulated Intramedullary Tumor Involving the Whole Spinal Cord from Medulla to Conus: Complete Enucleation with Recovery. Surg., Gynec. & Obst. **68:** 814–819, April 1939.

13. JEFFERSON, A.: Localized Enlargement of the Spinal Canal in the Absence of Tumour: A Congenital Abnormality. J. Neurol., Neurosurg. & Psychiat. **18:** 305–309, November 1955.

14. KERNOHAN, J. W., WOLTMAN, H. W., AND ADSON, A. W.: Gliomas Arising from the Region of the Cauda Equina: Clinical, Surgical and Histologic Considerations. Arch. Neurol. & Psychiat. **29:** 287–307, February 1933.

15. LOMBARDI, G., AND BIANCHI, M.: Aneurismi multipli del midollo spinale. Radiol. clin. **27:** 24–28, January 1958.

16. LOMBARDI, G., AND MIGLIAVACCA, F.: Angiomas of the Spinal Cord. Brit. J. Radiol. **32:** 810–814, December 1959.

17. RASMUSSEN, T. B., KERNOHAN, J. W., AND ADSON, A. W.: Pathologic Classification, with Surgical Consideration, of Intraspinal Tumors. Ann. Surg. **111:** 513–530, April 1940.

18. THERKELSEN, J.: Angioma racemosum venosum medullae spinalis. Acta psychiat. et neurol. scandinav. **33:** 219–231, 1958.

19. TÖNNIS, W., FRIEDMANN, G., AND NITTNER, K.: Zur röntgenologischen Diagnose und Differentialdiagnose der intraspinalen Tumoren; unter Berücksichtigung der klinischen Symptomatologie. Fortschr. a. d. Geb. d. Röntgenstrahlen **88:** 288–301, March 1958.

20. TUCKER, A. S., ARAMSRI, B., AND HUGHES, C. R.: Roentgenographic Diagnosis of Spinal Tumors. Am. J. Roentgenol. **78:** 54–65, July 1957.

21. WALKER, A. E.: Dilatation of the Vertebral Canal Associated with Congenital Anomalies of the Spinal Cord. Am. J. Roentgenol. **52:** 571–582, December 1944.

22. WOLTMAN, H. W., KERNOHAN, J. W., ADSON, A. W., AND CRAIG, W. M.: Intramedullary Tumors of the Spinal Cord and Gliomas of the Intradural Portion of the Filum Terminale. Fate of Patients Who Have These Tumors. Arch. Neurol & Psychiat. **65:** 378–395, March 1951.

23. WYBURN-MASON, R.: The Vascular Abnormalities and Tumours of the Spinal Cord and Its Membranes. London, H. Kimpton, 1944.

(*Pro le summario in interlingua, vider le pagina sequente*)

SUMMARIO IN INTERLINGUA

Tumores del Medulla Spinal

Inter 249 tumores del medulla spinal, 95 (38 pro cento) esseva accompaniate de alterationes ossee. In 4 pro cento il habeva calcificationes de visibilitate radiologic. In le majoritate del casos le tumores esseva locate in le spina thoracic (64,2 pro cento). Le altere sitos—in ordine de frequentia—esseva le regiones (*a*) cervical (17,2 pro cento), (*b*) lumbar (17 pro cento), (*c*) sacral (1,6 pro cento). Le localisation del tumores esseva intradural in 57 pro cento del casos, extradural in 17 pro cento, intramedullari in 15 pro cento, intra-extradural in 11 pro cento.

Le incidentia de alterationes ossee esseva 74 pro cento pro le tumores intra-extradural, 57 pro cento pro le tumores extradural, 35 pro cento pro le tumores intramedullari, 26 pro cento pro le tumores intradural.

In 4 pro cento del casos, multiple tumores esseva incontrate.

Le constatationes directemente radiologic e myelographic facite in tumores spinal—particularmente in casos de neurofibroma, meningioma, ependymoma, e tumores multiple—es discutite e evalutate criticamente.

Left Retrograde Cardioangiography: Its Diagnostic Value in Acquired and Congenital Heart Disease[1]

KURT AMPLATZ, M.D., RICHARD G. LESTER, M.D., RICHARD ERNST, M.D., and C. WALTON LILLEHEI, M.D.

RECENT ADVANCES in cardiac surgery have made necessary the development of more accurate diagnostic tests for certain acquired and complex congenital heart lesions. We have found left retrograde cardioangiography the most reliable means of diagnosis for both aortic and mitral valvular disease. It has proved useful also in certain cases of congenital heart disease, particularly intracardiac and extracardiac left-to-right shunts.

In this paper details of the technic employed at the University of Minnesota Hospitals will be given. In addition, the observations will be correlated with surgical data for patients who have been operated upon to date. Information concerning the relative diagnostic accuracy of conventional roentgenography will be included.

HISTORY

In 1933 Reboul and Racine (1) reported a technic for direct needle puncture of the left ventricle and injection of contrast material. In 1936 Nuvoli (2) opacified an aneurysm of the ascending aorta in a patient by this procedure. Ponsdomenech and Nunez (3) advocated direct heart puncture with contrast visualization of the right and left ventricles and reported the use of this method in 30 patients without fatality. These authors also coined the term "cardioangiography." More recently Lehman, Musser, and Lykens (4) have reported on this technic.

Radner (5) in 1949 described a method of catheterization of the ascending aorta *via* the radial artery. In his paper a roentgenogram showing the catheterization of the left ventricle by way of the aorta is reproduced. Zimmerman *et al.* (6, 7) reported successful retrograde catheterization of the left ventricle in 11 patients with aortic insufficiency. These authors attempted to catheterize 5 normal persons but were not able to pass the catheter through the aortic valve and concluded that catheterization of the left ventricle through the normal aortic valve was extremely difficult. Steinberg *et al.* (8) also found the passage of the catheter beyond the aortic valve difficult but reported one case of retrograde left ventricular catheterization. In 1957 Prioton *et al.* (9) published a report on left ventriculography by way of the femoral artery. They described a simple procedure of catheterizing the left ventricle *via* a percutaneous puncture of the left femoral artery, following the technic of Seldinger (10). These authors recognized the wide range of diagnostic possibilities of this method in congenital and acquired heart disease and listed its main indications. In 1958 and 1959 additional reports appeared (11–16). A brief paper outlining our experience in 120 cases has been published previously (17). More than 280 patients have now been examined by this means at the University of Minnesota Hospitals.

TECHNIC

The catheter may be introduced by an arteriotomy or percutaneously. The latter method will be described in detail.

Under local anesthesia the femoral artery, or occasionally the right brachial artery, is punctured with a 16-gauge arterial needle. A flexible guide wire and a 260 polyethylene catheter[2] are intro-

[1] From the Department of Radiology (K. A., Assistant Professor; R. G. L., Associate Professor) and the Department of Surgery (C. W. L., Professor), University of Minnesota Hospitals, Minneapolis, Minn., and the Department of Surgery (R. E., Assistant Professor), Southwestern Medical School, Dallas, Texas. This work was supported by a grant from the Minnesota Heart Association. Accepted for publication in September 1960.

[2] Made by F. Kotula, 3100 66th Ave. N., Minneapolis, Minn.

Fig. 1. One-plus mitral insufficiency; narrow regurgitating jet. Faint opacification of the left atrium.

duced percutaneously as described by Seldinger. The catheter has a curved tip and 4 to 6 side holes. The guide wire is left in the catheter in order to make it visible at fluoroscopy. The entire system is continuously flushed with heparinized saline solution, through a Teflon adapter tubing. The catheter is advanced into the ascending aorta, where the soft wire stylet is extended at least 4 cm. beyond the catheter tip. The guide wire is manipulated through the aortic valve under fluoroscopic control. If the aortic valve cannot be passed in a few minutes, the curvature of the catheter tip is changed by more or less extension of the wire stylet. This technic has several advantages over the conventional procedure:

1. Damage to the aortic valve leaflets is obviated because of the softness of the spring.

2. The curvature of the catheter can be changed by more or less extension of the stylet beyond the catheter tip.

3. The stylet can be removed and the injection made through a relatively thin-walled catheter which has less resistance than opaque catheters.

As soon as the stylet is passed through the valve, it is advanced rapidly into the region of the apex. The catheter is then advanced over the stylet which is now withdrawn. With a power injector 40 to 45 c.c. of a concentrated contrast material are delivered under low pressure. For evaluation of the mitral physiology, the injection should extend over approximately four consecutive systoles, which is usually about two or three seconds.

During the first two seconds roentgenograms are made in both planes at a rate of 5 films per second. Following this, 3 roentgenograms per second are made over a period of five seconds.

Pressures are recorded across the aortic valve and the catheter is repositioned in the ascending aorta with the tip approximately 2 to 3 cm. above the plane of the aortic valve. Thirty to thirty-five cubic centimeters of concentrated contrast material is injected under high pressure in order to evaluate competence of the valve. Roentgenograms are made in both planes at 5 films per second for two seconds.

INDICATIONS

The following are indications for left retrograde cardioangiography:

1. Evaluation of mitral competence in acquired heart disease.

2. Evaluation of mitral competence following operative correction of mitral heart disease.

3. Aortic valvular disease and suspected subvalvular or supravalvular stenosis (12).

4. Small intracardiac and extracardiac left-to-right shunts with questionable findings by right heart catheterization.

5. Balanced intraventricular septal defects not detected by oximetry.

6. Patent ductus arteriosus associated with pulmonary insufficiency or with ventricular septal defects.

7. Differentiation of aortic pulmonic window from patent ductus arteriosus.

8. Exact delineation of pathologic anatomy in coarctation of the aorta.
9. Demonstration of aortic ring (and other vascular anomalies).
10. Demonstration of coronary arteries.
11. Evaluation of the left side of the heart in complex congenital cardiac anomalies.
12. Differentiation between aortic insufficiency and pulmonary insufficiency in mitral heart disease.

ROENTGEN FINDINGS

Left ventricular injection of contrast material gives direct evidence of the presence and degree of mitral insufficiency. In combined states of mitral insufficiency and mitral stenosis some information concerning the stenosis of the valve may be obtained by evaluation of the size of the regurgitating jet. No direct information is gained, however, in states of pure mitral stenosis.

In our experience it is possible to estimate the degree of insufficiency only if the following conditions at the time of injection are fulfilled:

1. The catheter should be positioned near the apex and not in close proximity to the mitral valve.
2. A slow injection of contrast material is essential for accurate evaluation of the physiology of the mitral valve. Overfilling of the ventricle with contrast medium by rapid injection should be avoided.
3. Film studies should be made over a period of at least five to six seconds, since the late films indicate best the degree of insufficiency.

In a slow and controlled injection the contrast material is added to the ventricular blood during several cardiac cycles. If mitral insufficiency is present, some of the contrast material enters the left atrium. During the next systole new contrast material is added to the left ventricle. There is then a progressively increasing opacification of the left atrium. This progressive opacification of the left atrium is essential for the diagnosis of true mitral incompetence.

Fig. 2. Two-plus mitral insufficiency. Regurgitating jet larger than in Figure 1. The left atrium is fairly densely opacified.

The degree of mitral insufficiency can be estimated semiquantitatively as 1 to 4+. This is of great practical importance to the surgeon who must decide whether the mitral lesion should be corrected by closed or open technic.

In pure mitral stenosis the left atrium remains unopacified. In 1+ mitral insufficiency (Fig. 1) a narrow regurgitating jet is visible, and on late films the amount of contrast material present in the left atrium is definitely less than in the left ventricle and the aorta. In 2+ mitral insufficiency the regurgitating jet, as a rule, is usually larger and on the late films the left atrium appears to be almost as dense as the aorta (Fig. 2). In 3+ and 4+ insufficiency usually no clear regurgitating jet is demonstrated. The left atrium is markedly enlarged in most instances and is much more densely opacified than the aorta (Figs. 3 and 4).

Similar comments can be made in respect to the diagnosis of aortic insufficiency

Fig. 3. Three-plus mitral insufficiency. Dense opacification of a markedly enlarged left atrium.

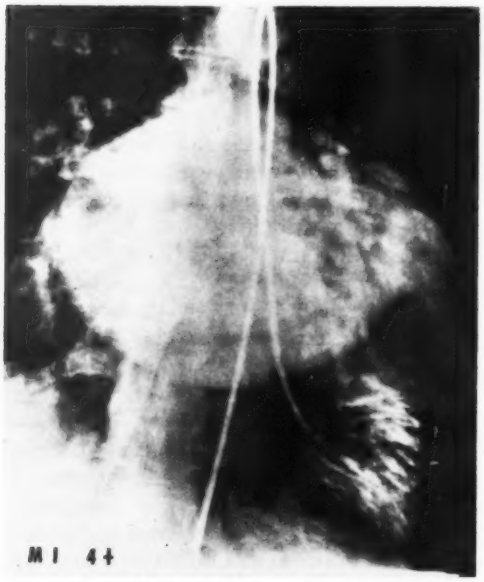


Fig. 4. Four-plus mitral insufficiency. Most of the opaque material seems to have collected in the left atrium. Giant left atrium with distended left atrial appendage.

by means of the injection above the aortic valve. In this case the injection obviously has to be made rapidly to opacify the aorta. In 1+ aortic incompetence the regurgitating jet is narrow and in most

TABLE 1: COMPARISON OF DIAGNOSIS OBTAINED BY LEFT RETROGRADE CARDIOANGIOGRAPHY WITH FINDINGS ESTABLISHED AT SURGERY IN 31 PATIENTS

Case Number	Operative Findings	X-ray Diagnosis by Conventional Method	X-ray Diagnosis by Cardioangiography
1	MI, AI	MI	MI, AI
2	AI	AI	AI
3	AI	MS	AI
4	AI	AI	AI
5	VSD and AI	PDA	VSD and AI
6	AI, MI	AI, Mitral heart disease	AI, MI
7	MI, AI	MI, AI	MI, AI
8	AI	AI	AI
9	MI	MI	MI
10	MI	MI	MI, no AI
11	MI	MI	MI
12	MI	AS	MI
13	MI with myopathy	MS, AS	MI
14	MI	Mitral and aortic disease	MI, no AI
15	MI, AI	MI	MI (AI not diagnosed)
16	MI, AI	MS	MI
17	MS, MI	MS, MI	MI, no AI
18	MI	MI	MI, no AI
19	MI	MI	MI
20	MS	MS	No MI
21	AI	AI	Minimal MI (False positive)
22	MI (Endocardial fibroelastosis)	MI (Endocardial fibroelastosis)	MI
23	MI, no AI	MI, AI	MI
24	MS	MI	No MI
25	MS	MS, minimal MI	No MI
26	MS, AS	MI	No MI, no AI
27	MI	MI	MI, no AI
28	AI, AS	AI, AS	AI, no MI
29	MS, mild AI	MS	AI, no MI
30	AI	AI	AI, no MI
31	AI, MS	AI, MS	AI, no MI

cases is just visible below the aortic valve (Fig. 6, B). In 2+ insufficiency the amount of regurgitating medium is larger and usually adequate to stain the left ventricle faintly. Three and 4+ insufficiencies are characterized by dense opacification of the left ventricle.

COMPLICATIONS

Two fatalities have occurred in association with this procedure. In one patient with severe mitral insufficiency the left atrium was entered accidentally and perforated. Injection of contrast material into the pericardial sac was followed by cardiac

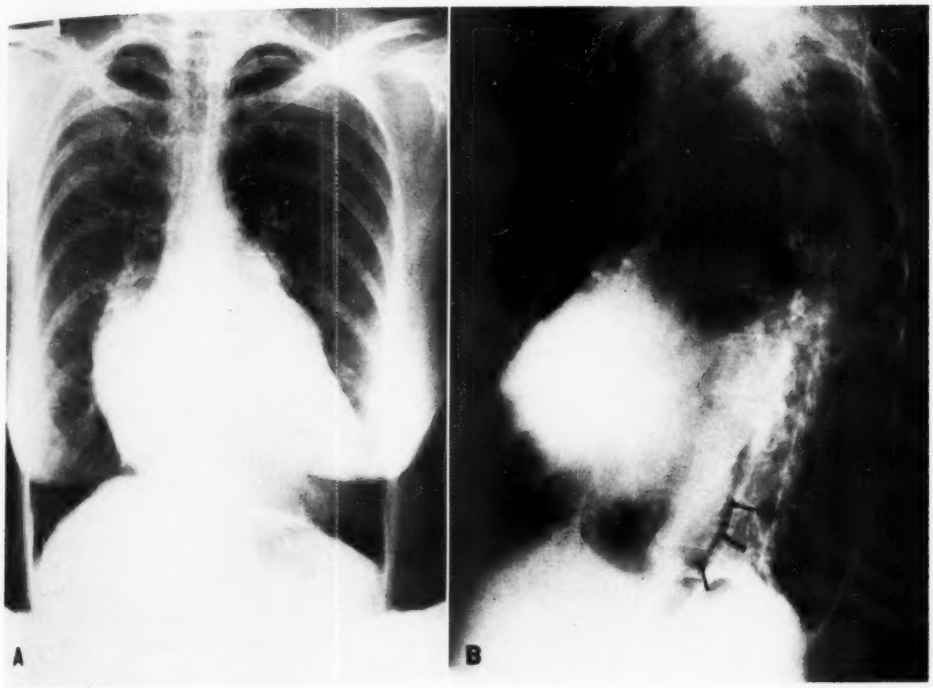


Fig. 5. Patient with mitral heart disease. A. Note markedly enlarged left atrium. B. Left anterior oblique view showing left ventricular enlargement suggesting mitral insufficiency.

tamponade. This patient succumbed the following day in spite of immediate surgical intervention. In a second case ventricular fibrillation ensued as soon as the catheter entered the left ventricle.

In most of our patients the catheter has been introduced by arteriotomy. In several arteriosclerotic patients an arteriectomy was necessary to restore good pulsatile flow in the femoral artery.

In one patient a local thrombus had to be removed surgically following percutaneous catheterization of the femoral artery. In another, part of the wire stylet broke off, requiring surgical removal, and was found in the adventitia of the femoral artery. On several occasions the stylet and the catheter entered a coronary artery. This event was readily recognized and was of no serious consequence.

RESULTS

More than 280 left retrograde cardioangiographic examinations have now been performed with the technic described above. Thirty-one patients have subsequently been operated upon. A comparison of the diagnosis obtained by left retrograde cardioangiography with the findings established at surgery is presented in Table I. As can be seen, there is one false positive and one false negative result. Subsequent review of these cases indicated that in each instance an actual diagnostic error was made in interpretation of the films. In the false positive (Case 21), a small subendocardial injection was misinterpreted as mitral insufficiency. In the false negative (Case 15), the roentgenograms were interpreted preoperatively as showing no evidence of aortic insufficiency. A review of the films, however, indicates the presence of definite aortic regurgitation, which correlated well with the operative finding of "mild aortic insufficiency."

Also included in Table I are the results of x-ray diagnosis by conventional methods (films and roentgen kymograms).

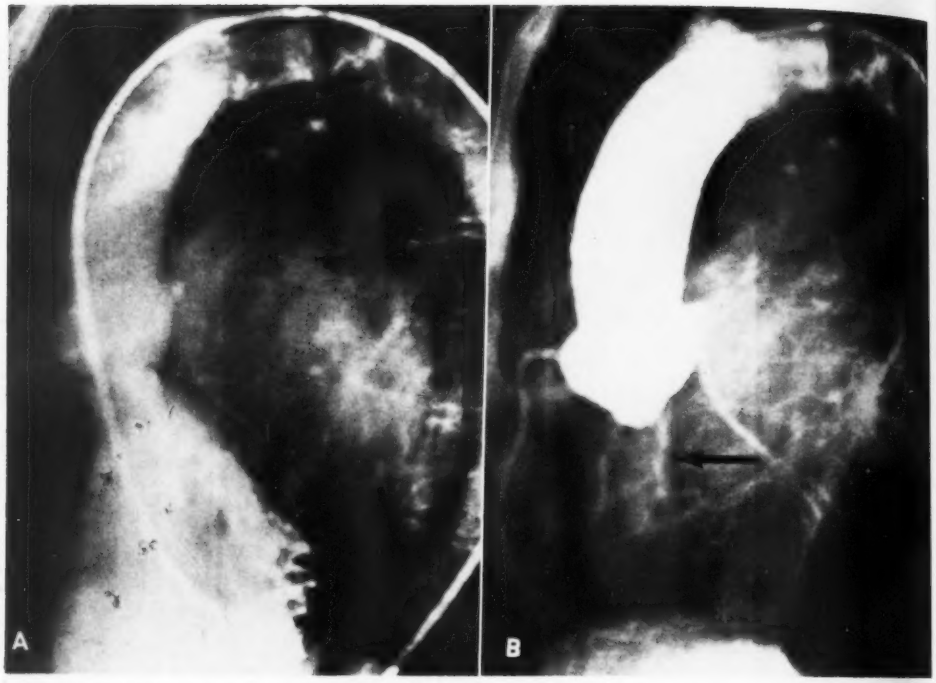


Fig. 6. A. Left ventriculogram showing no significant regurgitation to indicate the presence of mitral stenosis (confirmed by surgery).
B. Aortogram of same patient demonstrating 1+ aortic insufficiency (found at operation).

The plain films were interpreted by two of us. Surprisingly enough, a partial or complete misdiagnosis was made in approximately 40 per cent of the patients when conventional roentgen methods alone were employed. Misdiagnosis occurred particularly in cases where both valves were diseased. Diagnostic accuracy of conventional roentgen technic supplemented by clinical information is, of course, of a higher order. Even under these circumstances there is enough inaccuracy to make a more detailed technic essential, especially in patients in whom surgery is contemplated.

COMMENT

It is known that in normal animals mitral incompetence can be produced by the fast injection of contrast material into the left ventricle. In order to demonstrate small interventricular septal defects rapid injections into the left ventricle have at times been made. A run of ventricular extrasystoles followed, and the film studies showed opacification of the left atrium. Since in such cases there is presumably no mitral disease, artificially induced mitral insufficiency has to be postulated. That one is not dealing with true mitral incompetence can be readily recognized, since the contrast agent clears the left atrium immediately after a normal cardiac rhythm is re-established (Fig. 7). In mitral disease it is therefore desirable to deliver the contrast medium under low pressure during at least three to four consecutive ventricular systoles. Late film studies should be obtained to verify true mitral incompetence.

The possibility of fatalities, such as the two mentioned above, and local arterial complications make it necessary that the patients be observed for several hours following the procedure. In this institution some of the examinations are made by radiologists. A vascular surgeon should be available in case of arterial complication.

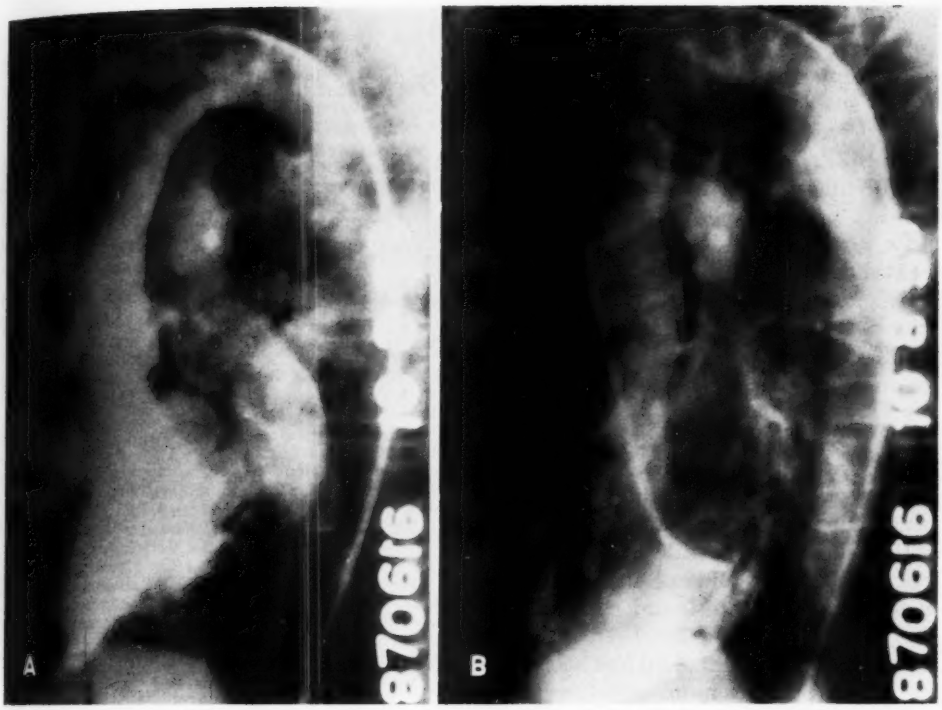


Fig. 7. A. Forceful injection into the left ventricle caused mitral regurgitation in patient with intraventricular septal defect and patent ductus.
B. Immediate clearing of the left atrium at the end of the injection, indicating artificially induced mitral insufficiency.

The results listed in Table I and a review of an additional 100 cases suggest that the experienced radiologist can make a correct precise diagnosis on plain films alone in approximately 60 to 70 per cent of cases if complicated lesions are included. A careful analysis of the roentgen features on the plain films showed no totally reliable signs differentiating the various types of mitral and aortic valvular disease, especially when present simultaneously. One of the main difficulties is the evaluation of left ventricular size. In the presence of right ventricular enlargement as usually associated with mitral heart disease, the left ventricle may be displaced far posteriorly, simulating left ventricular enlargement. In several cases, mitral insufficiency with left ventricular enlargement was thought to be demonstrated on plain films, but the retrograde cardioangiogram showed instead a left ventricle displaced by a large right ventricular chamber. The presence or absence of Kerley's lines was not particularly helpful in differential diagnosis of mitral disease. Marked cardiomegaly with a grossly enlarged left atrium is usually a good and consistent roentgen sign of mitral insufficiency although there are exceptions to this rule also (Figs. 5 and 6).

Fluoroscopic observation of aortic and mitral valvular calcifications are of diagnostic value and are particularly helpful to the surgeon. In our experience roentgen kymograms in postero-anterior and oblique projections are a reliable and sensitive means of obtaining permanent records of valve calcifications.

Prominence of the ascending aorta and the aortic arch are considered good evidence of associated aortic valvular disease since a heart with an isolated mitral lesion tends to have a relatively inconspicuous aorta. This is obviously true only for relatively

young patients. Increased pulsations of a prominent ascending aorta as seen at fluoroscopy (post-stenotic dilatation) are highly suspicious for aortic stenosis. In a fair percentage of cases it was possible to differentiate aortic stenosis from aortic insufficiency by kymography. In aortic stenosis only the post-stenotic segment, namely, the ascending aorta, shows increased pulsations. With significant aortic insufficiency, the anteroposterior kymogram usually shows increased pulsations in the descending thoracic aorta as well as in the arch and ascending portions.

SUMMARY

Left retrograde cardioangiography is considered reliable for evaluation of mitral and aortic incompetence, and is also useful in the diagnosis of certain congenital heart lesions. In the hands of the authors the method has had a high order of accuracy. The described technic has been utilized in more than 280 patients and has been found more reliable and more conclusive than conventional right heart catheterization. While not without risks, the procedure is thought to be definitely warranted in patients in whom corrective surgery is contemplated.

University of Minnesota Hospitals
Minneapolis 14, Minn.

REFERENCES

1. REBOUL, H., AND RACINE, M.: La ventriculographie cardiaque expérimentale. Presse méd. **41:** 763–767, May 10, 1933.

2. NUVOLI, I.: Arteriografia dell'aorta toracica mediante puntura dell' aorta ascendente o del ventricolo s. Policlinico (sez prat.) **43:** 227–237, Feb. 10, 1936.

3. PONSDOMENECH, E. R., AND NÚÑEZ, V. B.: Heart Puncture in Man for Diodrast Visualization of the Ventricular Chambers and Great Arteries. Its Experimental and Anatomophysiological Bases and Technique. Am. Heart J. **41:** 643–650, May 1951.

4. LEHMAN, J. S., MUSSER, B. G., AND LYKENS, H. D.: Cardiac Ventriculography. Direct Transthoracic Needle Puncture Opacification of the Left (or Right) Ventricle. Am. J. Roentgenol. **77:** 207–234, February 1957.

5. RADNER, S.: Technical Equipment for Vasal Catheterization. Acta radiol. **31:** 152–154, February 1949.

6. ZIMMERMAN, H. A., SCOTT, R. W., AND BECKER, N. O.: Catheterization of Left Side of Heart in Man. Circulation **1:** 357–359, March 1950.

7. ZIMMERMAN, H. A., AND HELLERSTEIN, H. K.: Cavity Potentials of Human Ventricles. Circulation **3:** 95–104, January 1951.

8. STEINBERG, M. F., SELIGMANN, A., KROOP, I. G., AND GRISHMAN, A.: Catheterization of Left Ventricle in Man. Study of Right Bundle Branch Block by Simultaneous Intracardiac Electrocardiography of Both Ventricles. Circulation **3:** 198–201, February 1951.

9. PRIOTON, J. B., THÉVENET, A., PELLISSIER, M., PUECH, P., LATOUR, H., AND POURQUIER, J.: Cardiographie ventriculaire gauche par cathétérisme retrograde percutane fémorale; technique et premiers résultats. Presse méd. **86:** 1948–1951, Nov. 27, 1957.

10. SELDINGER, S. I.: Catheter Replacement of the Needle in Percutaneous Arteriography. A New Technique. Acta radiol. **39:** 368–376, May 1953.

11. BONTE, G., CARON, J., PAUCHANT, M., AND GÉRARD, A.: Examen de l'aorte thoracique et du ventricule gauche par cathétérisme intra-ventriculaire à partir de la fémorale. J. de radiol. **39:** 593–598, October 1958.

12. PORSTMANN, W., GEISSLER, W., AND WOLF, W.: Die retrograde Lävokardiographie in Verbindung mit der intrakardialen Druckmessung. Fortschr. a. d. Geb. d. Röntgenstrahlen **89:** 397–409, October 1958.

13. PORSTMANN, W., AND GEISSLER, W.: Die retrograde Katheterisierung des linken Ventrikels von der Arteria femoralis und Arteria carotis communis dextra. Fortschr. a. d. Geb. d. Röntgenstrahlen **91:** 14–24, July 1959.

14. AMPLATZ, K., ERNST, R., LESTER, R. G., LILLEHEI, C. W., AND LILLIE, A.: Retrograde Left Cardioangiography as a Test of Valvular Competence. Radiology **72:** 268–269, February 1959.

15. HANSON, H. E., JÖNSSON, G., AND KARNELL, J.: Catheterization and Selective Roentgenographic Demonstration of the Left Ventricle of the Heart. Acta radiol. **52:** 33–44, July 1959.

16. DOTTER, C. T.: Left Ventricular and Systemic Arterial Catheterization: A Simple Percutaneous Method Using a Spring Guide. Am. J. Roentgenol. **83:** 969–984, June 1960.

17. AMPLATZ, K., ERNST, R., LESTER, R. G., THÉVENET, A., AND LILLEHEI, C. W.: Left Retrograde Cardioangiography in Rheumatic Heart Disease. Internat. Cong. Radiol. 1959, p. 230.

(Pro le summario in interlingua, vider le pagina sequente)

SUMMARIO IN INTERLINGUA

Cardioangiographia Retrograde Sinistre: Su Valor Diagnostic in Acquirite e Congenite Morbo Cardiac

Es describite le technica de cardioangiographia retrograde sinistre como illo esseva empleate in un serie de plus que 280 examines. Le methodo es considerate como digne de confidentia in le evalutation de incompetentia mitral e aortic. Illo es etiam utile in le diagnose de certe congenite lesiones cardiac. Inter le manos del autor, illo se ha provate capace de un alte grado de accuratia. In 31 casos in que operationes esseva executate, le resultatos includeva 1 de character false positive e un de character false negative. Le subsequente re-scrutinio del pelliculas demonstrava que il se tractava hic de errores de interpretation.

Ben que le methodo non es disproviste de riscos, il es opinate que su uso es definitemente justificate in patientes in qui chirurgia corrective es contemplate.

The Renal Arteries

An Evaluation of Roentgen Methods of Opacification[1]

SAMUEL D. HEMLEY, M.D., EDWARD J. ARIDA, M.D., and EDWARD M. RING, M.D.[2]

A STUDY OF THE presently available roentgenographic methods of opacifying the renal arteries has led us to the conclusion that percutaneous retrograde femoral catheter arteriography is the only complete and precise procedure. The relative hazards and technical problems encountered with other technics are a matter of general knowledge. Our interest lies simply in defining the limitations of the intravenous and translumbar needle arteriographic methods, particularly in the light of the ease and greater diagnostic value of the newer percutaneous method.

The following is a case presentation in which this point is illustrated:

E. B., a 44-year-old Negro woman, was admitted to St. Luke's Hospital for the fourth time in June 1960, complaining of increasing blurring of vision and weakness. She was known to have had hypertension since 1955, although she had been asymptomatic until 1958, when headaches and visual disturbances developed. Her admissions to St. Luke's Hospital had begun early in 1959, when she was seen for progressive complications of her disease, including congestive heart failure, 4+ hypertensive retinopathy, weakness, and blurred vision. Blood pressures were in the range of 210/115.

On her earlier admissions, laboratory tests demonstrated albuminuria with no formed elements and several negative urine cultures; blood urea nitrogen 12.3 mg. per 100 c.c.; creatinine 0.8 mg. per 100 c.c.; normal electrolytes; phenolsulfonephthalein excretion 53 per cent in one hour, 21 per cent in the first fifteen minutes. The Regitine test was negative. Differential salt excretion studies showed equal concentrations bilaterally, in the normal range.

An intravenous urogram demonstrated minimal caliectasis on the right. This was verified by retrograde pyelography.

The blood pressure and symptoms failed to respond to the usual medical regimen and consequently a sympathectomy was contemplated. Before this procedure was carried out, however, it was felt proper to exclude any correctable renal vascular disease. In January 1960, therefore, intravenous aortography was performed but failed to delineate the renal arteries adequately, although the aorta and its peripheral branches were well opacified (Fig. 1, A). This procedure was followed by a translumbar aortic puncture with excellent visualization of the right renal artery but poor demonstration of the left (Fig. 1, B). It was not possible to exclude surgically correctable structural alterations of these vessels on the basis of either of these two diagnostic studies.

On readmission in June 1960, a normal renal arterial structure bilaterally was demonstrated (Fig. 1, C) after percutaneous retrograde aortic catheterization.

The demonstration of structural changes in the renal arteries in selected hypertensive patients is at the present time an accepted clinical step in determining possible etiology and in the selection of candidates for surgery. Theoretically, the patient with early, relatively uncomplicated hypertension is indeed fortunate if surgically correctable anatomic changes in the renal vasculature are demonstrated, since he is potentially "curable" under present clinical standards. Consequently, if cure is to take precedence over management in the philosophy of the treatment of hypertension in the future, here is the beginning.

The premise of cure, however, depends on discovery. The usually applied function studies, including the differential salt excretion tests, are often inconclusive, even misleading. The demonstration of the various degrees of renal vascular insufficiency must inevitably depend upon conclusive, unequivocal, visually apparent anatomic changes, with the presently available opacification technics. There are three well publicized methods of demonstrating the renal arteries roentgenographically: the intravenous arteriographic, the translumbar needle aorto-

[1] From the Department of Radiology (S. D. H., Acting Director; E. J. A., First Assistant Resident and National Institutes of Health Cancer Trainee), St. Luke's Hospital, New York, N. Y. Accepted for publication in August 1960.

[2] Resident Surgeon, Department of Surgery, St. Luke's Hospital, New York, N. Y.

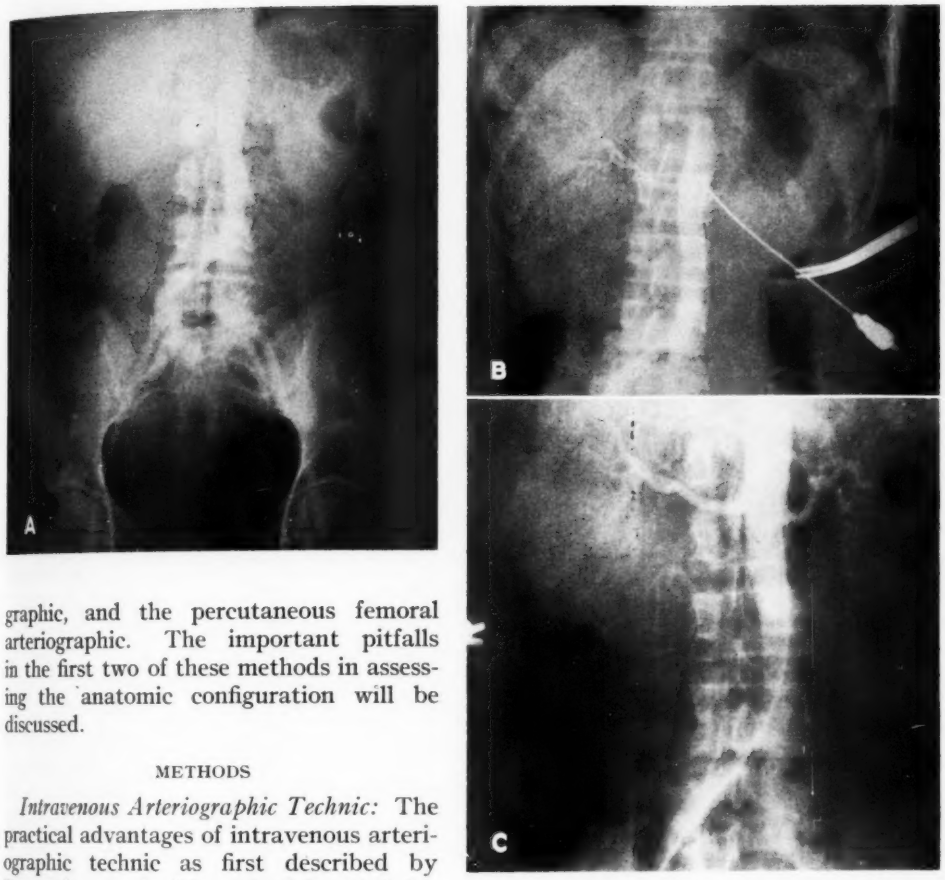


Fig. 1. Case E. B. A. Intravenous aortogram with inadequate visualization of the renal arteries. B. Translumbar aortogram with excellent visualization of right renal artery and poor demonstration of the left. C. Normal renal arteries demonstrated after percutaneous retrograde catheter injection.

graphic, and the percutaneous femoral arteriographic. The important pitfalls in the first two of these methods in assessing the anatomic configuration will be discussed.

METHODS

Intravenous Arteriographic Technic: The practical advantages of intravenous arteriographic technic as first described by Bernstein *et al.* (1) and elaborated by Steinberg *et al.* (13) are evident. Equipment is of low cost. The study is completed swiftly, and the risk to the patient is no greater than the risk of rapid injection of large quantities of concentrated contrast substances, which to date has been negligible. In over 25 such studies performed by us in the past four months, delineation of the aorta and its peripheral branches has in the majority of cases been excellent, and valuable information has been gathered as to obstructive changes, irregular plaque formation, and collateral development.

The few publications on this technic allude to its possibilities for study of the renal arteries. Steinberg *et al.* state: "Complete opacification of the circulatory system in man is now feasible" (13). We feel that a widespread misconception has resulted as to its value in this respect. In our hands, intravenous arteriography, as described by Steinberg *et al.*, with a few minor variations has consistently failed to demonstrate the renal arteries with enough clarity to warrant a decision as to surgical intervention. In many studies these arteries are easily identifiable, but their margins are often blurred. The celiac axis and mesenteric vessels are frequently superimposed on the renal vessels. Blurring is a result of the prolonged exposure which is a necessary part

Fig. 2. Intravenous aortogram with good visualization of the aorta and its bifurcation. The renal vessels are inadequately demonstrated.

of the technic. Since the method is completely unselective, any or all of the aortic branches are indiscriminately opacified. Preservation of a large enough contrast bolus through the lesser circulation is partially accomplished by the use of large quantities (often 100 c.c.) of concentrated medium. Many factors, however, tend to destroy the bolus. In patients with significantly prolonged circulation times (usually over 25 seconds, Decholin, arm-to-tongue) or in those with mitral stenosis, for example, the bolus is often dissipated, either in the congested lesser circulation or in the obstructed left-sided outflow tract.

The determination of a sharp end-point based on the conventional circulation time is also a limiting factor in capturing the opacification of the renal arteries on a single roentgenogram. The use of radioactive detectors as described by Bernstein (1) seems to us overly cumbersome and expensive.

In the absence of aortic obstruction, intravenous arteriography is inadequate for the demonstration of structural changes in the renal arteries with sufficient clarity

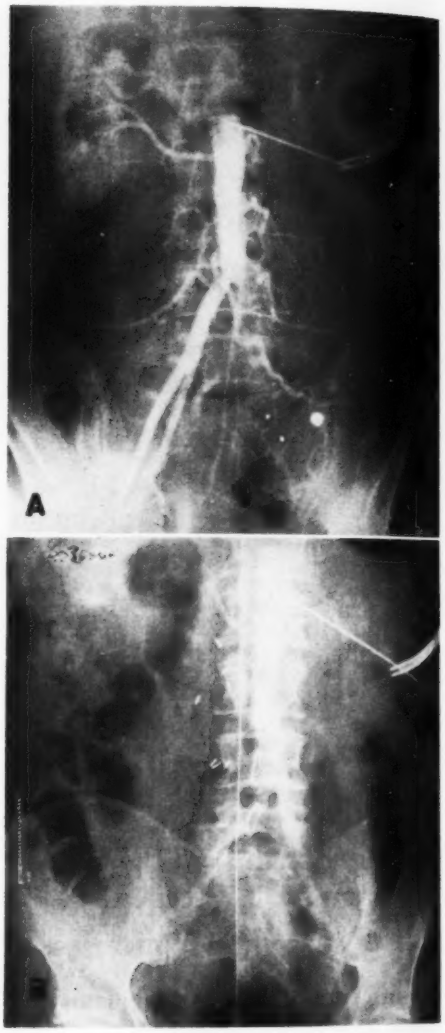


Fig. 3. Visualization of the right renal artery with nonvisualization of the left, a common occurrence in translumbar aortography. Note complete obstruction of the left common iliac artery in Figure 3, A.

to warrant surgical intervention (Fig. 2).

Translumbar Needle Aortography: Despite the hazards of translumbar needle aortography, it is commonly accepted as an important method in the study of peripheral vascular disease and in demonstrating the renal vascular structures. In a significant number of cases in our experience, however, it failed to opacify the left renal artery. This might well be

interpreted as a sign of a pathologic condition, but with one exception (8) it is not mentioned in the surgical literature (4–6, 9, 10, 14).

We believe this deficiency to be inherent in the procedure itself. Since the needle is introduced from the left side and directed toward the aorta somewhat anteriorly and to the right, it inevitably faces the right renal artery. Arterial opacification is determined by the direction of blood flow and the direction toward which the opening of the indwelling needle lies. There are situations, therefore, when nonfilling of the left renal artery occurs, leading to the erroneous impression of vascular obstruction. Since the translumbar method is a relatively blind procedure, the entire volume of contrast material may be injected directly into the right kidney instead of being distributed bilaterally.

In an article describing their results with percutaneous transfemoral selective renal arteriography, Gregg and his associates (7) list concisely several defects in the translumbar approach, which are in perfect agreement with the analysis of our cases. The points are well demonstrated in the case reported in the first part of this paper.

Not only does failure to visualize the left renal artery occur (Fig. 3) in translumbar aortography, but neither renal vessel may be seen. In a series of 127 abdominal aortograms, the renal arteries were incidentally visualized in only 40 per cent of the cases. Of an additional 15 abdominal aortograms obtained for study of renal disease, only 9 were diagnostic (6).

Translumbar aortography is considered dangerous from the standpoint of renal toxicity (8), and some advise against its performance in patients with poor renal function (3). In a recent report, Crawford *et al.* (4) mentioned renal injury as the most common significant complication and referred to 12 cases of unilateral damage resulting from direct injection of the right renal artery. Miller *et al.* (9) reported a 3 per cent incidence of renal damage following translumbar aortography. In 3 cases, the direct forceful injection of a sizable amount of contrast material into a single renal artery produced unilateral injury. In the opinion of Foster and Killen (6) the possibility of detecting a renal arterial cause of hypertension justifies the increased risk of aortography in patients with pre-existing disease. This is disputed by others (2, 3, 15). Samuel and Denny (15) suggest that a greater use be made of percutaneous retrograde aortography by Seldinger's method.

Fig. 4. Percutaneous retrograde catheterization of the femoral artery with opacification of the renal arteries.

Percutaneous Retrograde Femoral Catheter Arteriography (Fig. 4): The percutaneous retrograde femoral catheter technic as outlined by Seldinger (12) and later discussed by Ödman (11) is precise. Placement of the catheter tip is easily controlled and checked with a scout film. It is usually possible to obtain excellent renal detail without filling all the celiac axis, a matter that is left purely to chance in the needle-puncture method. Distribution of the medium is ideal for opacifying both renal arteries, after delivering the bolus above the origin of the renal vessels. This method permits the use of smaller amounts of contrast medium.

SUMMARY AND CONCLUSIONS

Three methods of renal artery opacification have been discussed. Roentgenograms are presented which define the limitations of the translumbar and intravenous methods.

Our experience, which is substantiated by an analysis of current literature, indicates that the safest, most practical, and technically the most adequate method of investigation is percutaneous catheterization of the aorta through the femoral artery approach. A case is presented which illustrates these findings and clearly defines the limitations of the two older methods of study.

St. Luke's Hospital
Amsterdam Ave. and 113th Street
New York 25, N. Y.

REFERENCES

1. BERNSTEIN, E. F., GREENSPAN, R. H., AND LOKEN, M. K.: Intravenous Abdominal Aortography: A Preliminary Report. Surgery **44:** 529–535, September 1958.
2. BURNS, E., AND HENDON, R. G.: Aortography as an Aid in the Management of Renal Lesions. Ann. Surg. **139:** 617–623, May 1954.
3. CONGER, K. B., REARDON, H., AND AREY, J.: Translumbar Aortography Followed by Fatal Renal Failure and Severe Hemorrhagic Diathesis. Arch. Surg. **74:** 287–293, February 1957.
4. CRAWFORD, E. S., BEALL, A. C., MOYER, J. H., AND DE BAKEY, M. E.: Complications of Aortography. Surg., Gynec. & Obst. **104:** 129–141, February 1957.
5. DUSTAN, H. P., PAGE, I. H., AND POUTASSE, E. F.: Renal Hypertension. New England J. Med. **261:** 647–653, Sept. 24, 1959.
6. FOSTER, J. H., AND KILLEN, D. A.: Aortography and Peripheral Arteriography: An Analysis of Results in a University Medical Center. Ann. Surg. **149:** 321–341, March 1959.
7. GREGG, D. M., ALLCOCK, J. M., AND BERRIDGE, F. R.: Percutaneous Transfemoral Selective Renal Arteriography (Including Cineradiology). Brit. J. Radiol. **30:** 423–435, August 1957.
8. KINCAID, O. W., AND DAVIS, G. D.: Abdominal Aortography. New England J. Med. **259:** 1017–1024, Nov. 20, 1958.
9. MILLER, G. M., WYLIE, E. J., AND HINMAN, F., JR.: Renal Complications from Aortography. Surgery **35:** 885–896, June 1954.
10. MORRIS, G. C., JR., DE BAKEY, M. E., COOLEY, D. A., AND CRAWFORD, E. S.: Surgical Treatment of Renal Hypertension. Ann. Surg. **151:** 854–866, June 1960.
11. ÖDMAN, P.: The Radiopaque Polythene Catheter. Acta radiol. **52:** 52–64, July 1959.
12. SELDINGER, S. I.: Catheter Replacement of the Needle in Percutaneous Arteriography. A New Technique. Acta radiol. **39:** 368–376, May 1953.
13. STEINBERG, I., FINBY, N., AND EVANS, J. A.: A Safe and Practical Intravenous Method for Abdominal Aortography, Peripheral Arteriography, and Cerebral Angiography. Am. J. Roentgenol. **82:** 758–772, November 1959.
14. STOKES, J. M., AND BUTCHER, H. R., JR.: Complications of Translumbar Aortography Related to Site of Injection. Arch. Surg. **75:** 770–775, November 1957.
15. SAMUEL, E., AND DENNY, M.: An Evaluation of the Hazards of Aortography. Arch. Surg. **76:** 542–545, April 1958.

SUMMARIO IN INTERLINGUA

Le Arterias Renal: Un Evalutation de Methodos Roentgenologic

Es discutite tres methodos de opacification de arteria renal: le methodo arteriographic intravenose, le methodo aortographic a agaulia translumbar, e le methodo arteriographic femoral percutanee. Le limitationes del prime duo methodos es signalate, e roentgenogrammas es presentate que illustra le riscos de lor uso in le evalutation del configuration anatomic del renes.

Es opinate que catheterismo femoral retrograde percutanee es le sol methodo complete e precise pro opacificar le arterias renal. Iste methodo es etiam reguardate como le plus secur, le plus practic, e technicamente le plus adequate. Le placiamento del apice del catheter es facile a regular e controlar per medio de un radiogramma de surveliantia. Un excellente detalio renal pote esser obtenite sin que le axe celiac es replenate completemente. Isto es un aspecto que depende totalmente del bon fortuna in le uso del methodo a punctura per agulia. Le distribution del medio es ideal pro opacificar ambe arterias renal, providite que le bolo es delivrate supra le origine del vasos renal. Plus micre quantitates de materia de contrasto es requirite que in le altere methodos.

Non-Strangulating Distal Ileal Obstruction

Part I: The Role of Hydration. An Experimental Study Correlating Pathologic and Radiologic Findings[1]

ROBERT D. SLOAN, M.D., JOSEPH W. BROCK, M.D., and WILLIAM M. FANT, M.D.

A VOLUMINOUS literature is available dealing with many of the experimental and clinical aspects of intestinal obstruction. Relatively little effort, however, has been made experimentally to evaluate pre-obstruction base-line factors that might influence the gross changes occurring in the intestinal tract following obstruction. In addition, the emphasis in the radiologic literature has been on the clinical aspects of obstruction, with only scattered articles reporting experimental observations.

It is proposed at this time to present the first of a series of studies on intestinal obstruction. Specifically, an attempt will be made to evaluate the role of hydration in the rate of development, the extent of the gross dilatation, and the nature of the luminal contents occurring in experimentally produced, complete, non-strangulating obstructions of the distal ileum. The radiologic findings will be correlated with the gross anatomic patterns.

METHOD OF STUDY

Obstruction was produced by essentially the same method in 60 mongrel dogs. Under intravenous 2 per cent Surital sodium (thiamylal sodium) anesthesia and sterile conditions, a midline abdominal incision was made. The ileocecal junction was identified and a point in the ileum roughly 30 cm. proximal to this was selected for the obstruction site. A small rent was made in the avascular portion of the mesentery close to the bowel wall, and a strip of gauze was placed completely around the circumference of the intestine. A tight ligature of stainless steel was then placed over the gauze, thus producing complete, non-strangulating obstruction. The abdominal incision was closed in layers, following which recumbent anteroposterior and postero-anterior, as well as erect postero-anterior, radiographs of the abdomen were obtained. No animal received anything by mouth during the entire postoperative period.

TABLE I: PLAN OF STUDY

	Hours Fasting	Intravenous Supplement at Surgery	Number of Experiments	
			6-Hour Study	24-Hour Study
Group I	24	Yes	10	10
Group II	24	No	10	10
Group III	48	No	10	10

The 60 dogs used in the study were divided into three groups of 20 each, as follows.

Group I: The animals were allowed nothing by mouth for twenty-four hours prior to surgery. Starting with the induction of anesthesia and extending over the next sixty to ninety minutes, normal saline was given intravenously, 60 c.c. per kilogram of body weight.

Group II: The animals were given nothing by mouth for twenty-four hours preoperatively, with no fluid supplement at the time of surgery.

Group III: The animals received nothing by mouth for forty-eight hours preoperatively, and no fluid supplement at the time of surgery.

Each group was further subdivided according to the length of time the animals were followed after surgery. In each of the three groups 10 dogs were followed for six hours, and 10 for twenty-four hours (Table I).

[1] From the Department of Radiology, The University of Mississippi Medical Center, Jackson, Miss. This study was supported by a grant from the U. S. Department of Health, Education, and Welfare. Accepted for publication in August 1960.

At the completion of each experiment (either six or twenty-four hours) the dog was again anesthetized with intravenous Surital sodium and a repeat series of recumbent and erect radiographs was obtained. Promptly thereafter the animal was exsanguinated through a catheter placed in a femoral artery. During the bleeding procedure the abdominal incision was reopened, the obstruction site identified, and the general appearance of the intestinal tract and peritoneal cavity noted. At death the lower thoracic aorta was clamped and the abdominal contents were embalmed with 10 per cent formalin. After a delay of only a few minutes the abdominal portion of the intestinal tract was removed *en bloc* and examined. In each instance the following data were recorded.

1. Distances from ileocecal junction and pylorus to obstructive site.
2. Length of the dilated segment of small intestine above the obstructive site.
3. Diameter of the lumen of the ileum just above and below the point of obstruction.
4. Nature and rough estimate of the quantity of contents in the entire small bowel above and below the obstructive site and in the stomach and colon.

The stomach and small intestine of the dog are essentially empty of food and food products after twenty-four hours with nothing by mouth. In this sense, therefore, all of the animals in the study were fasting. The only planned variable related to the state of hydration. The dogs in Group I were well hydrated; those in Group III were dehydrated, with Group II occupying an intermediate position. It was felt that the six-hour and twenty-four-hour divisions in each group would offer some data on the role of hydration in the early and moderately advanced stages of obstruction.

The abdominal films obtained just prior to the termination of each experiment provided an opportunity for the correlation of the radiographic appearance with the gross anatomical findings noted at autopsy. The initial films, made just after the production of the obstruction, served as a base line in each animal for evaluation of those taken subsequently.

FINDINGS

In general, the animals appeared to tolerate the surgery and obstruction quite well. The average dog showed initial evidence of recovery from anesthesia one to one and a half hours after surgery. By six hours the majority could stand and walk, often with imperfect control of the hind extremities. At twenty-four hours the animals were uniformly able to walk and, while some appeared rather lethargic, many were without apparent discomfort of any sort. There was no obvious correlation between the general appearance of the animal and the degree of obstructive changes encountered at autopsy. Obvious vomitus on the floor of the cage was recorded in only 7 of the 60 studies but, since the stomach was empty of food, the presence of clear fluid or mucoid vomitus could have passed undetected.

Autopsy measurements revealed that the average distance from the obstruction site to the ileocecal junction in the 60 animals was 29 cm., with a maximum of 92 cm. and a minimum of 14 cm. In all experiments the stainless steel ligature appeared to occlude completely the lumen of the bowel.

In 56 of the 60 dogs there was evidence of functional mechanical obstruction at autopsy. Functional obstruction was considered to be present when the circumference of the ileum above the obstruction was obviously greater than that below the point of obstruction. In 43 of the 60 studies there was clear radiologic evidence of small-intestinal obstruction on the films obtained at the termination of each experiment. In 11 instances the radiologic findings were felt to be indeterminate, and in the remaining 6 experiments there were no findings on the films suggesting mechanical obstruction. A break-down comparison between the pathologic and radiologic findings in the six-hour studies is given in

TABLE II: CORRELATION BETWEEN PATHOLOGIC AND RADIOLOGIC EVIDENCES OF OBSTRUCTION: SIX-HOUR STUDIES

	Pathologic Obstruction		Radiologic Obstruction		
	+	−	+	−	?
Group I: NPO 24 hr.; IV fluids	10	0	7	0	3
Group II: NPO 24 hr.; No fluids	8	2	6	0	4
Group III: NPO 48 hr.; No fluids	8	2	3	5	2

TABLE III: CORRELATION BETWEEN PATHOLOGIC AND RADIOLOGIC EVIDENCES OF OBSTRUCTION: TWENTY-FOUR-HOUR STUDIES

	Pathologic Obstruction		Radiologic Obstruction		
	+	−	+	−	?
Group I: NPO 24 hr.; IV fluids	10	0	10	0	0
Group II: NPO 24 hr.; No fluids	10	0	8	0	2
Group III: NPO 48 hr.; No fluids	10	0	9	1	0

Table II, and for the twenty-four hour studies in Table III.

In attempting to quantitate the obstruction, the length of the dilated segment of small intestine above the site of occlusion was recorded in each instance. In many animals there was a fairly abrupt change from obviously dilated to normal-sized bowel as one progressed proximally from the obstruction site (Fig. 1), but occasionally the transition was more gradual and here accurate measurement was obviously difficult. In rare instances the dilatation was erratic in pattern, with areas of dilated bowel alternating with segments of more normal size. Another method used in evaluating the length of the dilated segment was to relate it to the total length of the small bowel from the site of obstruction to the pylorus. This would tend to correct for variations in size and length of the intestinal tract from dog to dog. The average length of the dilated segment in the 30 animals followed for six hours was 62 cm.; in those followed for twenty-four hours, 134 cm. Related to the total length of the small bowel above the obstruction site, the average dilatation was 31 per cent in the six-hour studies and

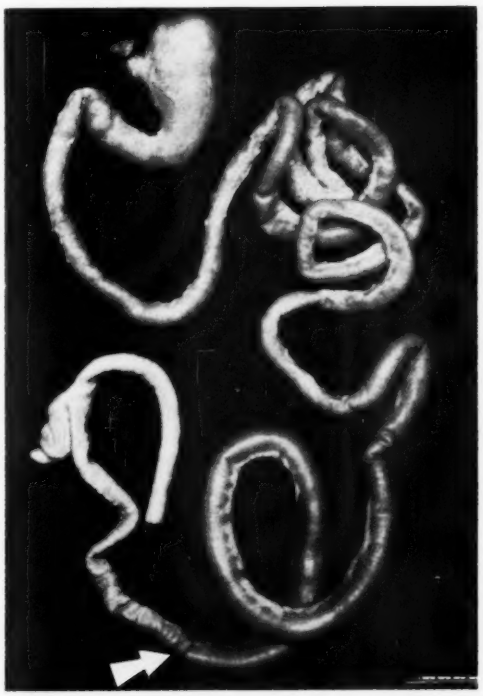


Fig. 1. One of the autopsy specimens from the present study showing the typical changes occurring in the size of the ileum following the establishment of complete, non-strangulating obstruction. Note the dilated loops above the point of obstruction, with the fairly abrupt return to normal-sized loops as one progresses proximally. The collapsed distal ileum and proximal colon are shown to good advantage.

56 per cent in the twenty-four-hour experiments. While there were wide variations between individual experiments in the measurements obtained, it did not appear that the state of hydration significantly influenced the results.

Another quantitative measurement of obstruction evaluated in the study concerned the lumen of the intestine just above the obstruction site. In the six-hour studies the average diameter was 11 mm., with individual variations from 2 to 18 mm. In the 30 dogs followed for twenty-four hours, the average diameter was 15 mm. (minimum 8 and maximum 20 mm.). Again, there was no significant difference between the three groups.

The diameter of the lumen just below the obstruction site was also recorded in each autopsy. There was no significant

difference between the three groups or in the six- and twenty-four-hour studies in this measurement, the average being 4 mm., with an individual variation from 2 to 10 mm.

While quantitative measurements of the luminal contents of the intestinal tract were not made, their nature and gross appearance at autopsy were recorded in each instance. No significant difference was noted in the small-bowel contents distal to the obstruction in the three groups or between the six- and twenty-four-hour studies. In most instances relatively small amounts of mucoid material were noted, and frequently this was thick and inspissated, while the mucosa had a dry appearance. In 10 of the 60 autopsies gas was encountered in the segment of ileum distal to the obstruction; 6 of these observations were made in the six-hour studies and the remaining 4 in the twenty-four-hour experiments.

The dilated portion of the small bowel proximal to the obstruction contained varying amounts of gas and fluid or mucoid material. As would be expected, the quantity of gas and fluid was in general greater in the animals followed for twenty-four hours. A significant difference was noted in the viscosity of the non-gaseous contents in the dilated small-bowel loops in the six- and twenty-four-hour studies. In the majority of the twenty-four-hour obstructions the fluid was of a watery consistency, while in the six-hour studies the material was frequently mucoid and viscous in nature, occasionally to such a degree that it could be scooped up on the handle of a scalpel. The degree of viscosity is of practical importance, since it influences the ease with which air-fluid levels are formed. In the six-hour studies, 27 of the 30 autopsies revealed the contents of the dilated loops to have some element of viscosity, while in the twenty-four-hour group only 7 of the 30 autopsies exhibited this feature. The state of hydration did not appear to influence grossly the viscosity picture or the amount of fluid found in the dilated loops. In Table IV the correlation between the viscosity of the contents and the radiologic demonstration of air-fluid levels is given.

TABLE IV: CORRELATION BETWEEN VISCOSITY OF DILATED LOOP CONTENTS AND PRESENCE OF RADIOGRAPHIC AIR-FLUID LEVELS

	Air-Fluid Levels	
	Present	Absent
Fluid viscous: 34 autopsies	17	17
Fluid non-viscous: 26 autopsies	26	0

While at autopsy the state of hydration did not appear grossly to be related to the quantity of gas found in the obstructed loops, the radiographs offered another method of evaluating the quantity and distribution of gaseous contents, and each set of films was evaluated as to the presence or absence of demonstrable gas-filled dilated loops of small intestine. In the twenty-four-hour experiments, dilated gas-filled loops could be identified 28 times; questionably dilated loops were observed in the remaining 2 studies. The lumina of these dilated loops, as measured on the radiographs, averaged 18 mm. in diameter, with individual variations from 11 to 24 mm. The patterns observed were essentially equal and similar in all three groups. In the six-hour studies, however, there was a difference between the three groups as regards the number of cases showing dilated gas-filled loops on the radiographs. This difference is summarized in Table V.

TABLE V: INCIDENCE OF RADIOLOGICALLY DEMONSTRABLE GAS-FILLED OBSTRUCTED LOOPS: SIX-HOUR STUDIES

	Dilated Gas-Filled Loops		
	Present	Absent	Questionable
Group I: NPO 24 hr.; IV fluids	8	0	2
Group II: NPO 24 hr.; No fluids	4	4	2
Group III: NPO 48 hr.; No fluids	3	5	2

The diameters of the lumina of the dilated loops, when identified on the six-hour films, averaged 16 mm. in the three groups.

The non-dilated segments of the ileum and jejunum proximal to the distended loops were for the most part essentially empty at autopsy, save for small quantities of mucoid material and gas. Bile-stained fluid was usually present in the duodenum and upper jejunum.

The stomach at autopsy usually contained gas and fluid or mucoid material, the proportions varying from case to case. The fluid or mucoid component was usually small to moderate in amount, and in only one instance was the stomach considered to be actually dilated. In approximately half of the 60 studies there was some increase in size of the stomach on the six- or twenty-four-hour radiographs as compared with the base-line films obtained immediately following surgery. In many of these cases it was obvious at autopsy that the salivary and gastric secretions were pooling in the stomach, due either to pylorospasm or diminished gastric peristaltic activity. Only rarely had the fluid contents from the obstructed small-bowel loops backed up into the stomach, although the gastric contents showed some bile staining in 31 of the 60 autopsies. The size and contents of the stomach exhibited no significant variation between the three groups or in the six- and twenty-four-hour studies.

The colon was not distended in any of the examinations, being either empty or containing small to moderate amounts of soft to firm feces. Occasional gas pockets were noted along its course.

DISCUSSION

Following the establishment of complete non-strangulating distal ileal obstruction, a progressive distention of the intestinal loops develops above the obstructive site. This distention is related to an increasing accumulation of gas and fluid in the lumen of the intestine. The gaseous component arises from swallowed air (68 per cent), gaseous interchange with the blood circulating through the bowel wall (20 per cent), and from the action of bacteria upon intestinal contents (12 per cent) (2, 4). In the present study no effort was made to control these factors, other than the fact that all animals were left in a right lateral position during the postoperative period while recovering from the effects of the anesthetic.

The distending fluid constituents are derived from fluids ingested orally, digestive glandular secretions, and fluid fractions from the blood stream passing into the bowel lumen (2). In the current study orally ingested fluids were eliminated. One of the prime purposes was to ascertain, if possible, whether or not varying degrees of dehydration would influence grossly the quantities of glandular secretions or blood-stream fractions entering the intestinal tract proximal to the obstructive site.

Before analyzing the present findings, however, some of the limitations of an experimental study of this type should be pointed out. Dehydration itself, for example, is a complicated situation when one becomes involved in plasma, interstitial, and intracellular fluid components (5). In the present study no effort was made to quantitate the degree of dehydration occurring in the animals. Most workers attempting to do quantitative experimental studies on the intestinal tract have been plagued by marked individual variations in the response of animals to a given stimulus (1, 6, 7), and this investigation is certainly no exception. With such a wide range of individual variation, averages are somewhat less meaningful. The unavoidable surgical trauma to the small intestine varied considerably from animal to animal. In some instances the ileocecal junction was identified after running only a few centimeters of the small intestine, while on other occasions it proved necessary to handle long segments. Thus the paralytic component associated with the anesthesia and the operative procedure presumably varied from experiment to experiment. With rare exceptions, however, the gross pattern at autopsy was that of mechanical rather than paralytic obstruction.

With these limitations in mind, certain conclusions can be reached in the present study. On analysis first of the gross autopsy findings, it is apparent that the experimental technic used was effective in producing functional mechanical obstruction in most of the animals (56 of 60 dogs, or 93 per cent). On the average, roughly one-fourth of the small intestine proximal to the obstruction site showed evidence of gross dilatation at the end of six hours, with the hydrated dogs in Group I showing a more uniform pattern of obstruction than did the more dehydrated animals.

Accurate radiologic evaluation of intestinal tract obstruction in the dog necessitates a knowledge of the normal gross anatomy of the intestinal tract. A comparison of the anatomy of the stomach, duodenum, and colon of the dog and man is presented in Figures 2 and 3. A major difference not illustrated is the absence

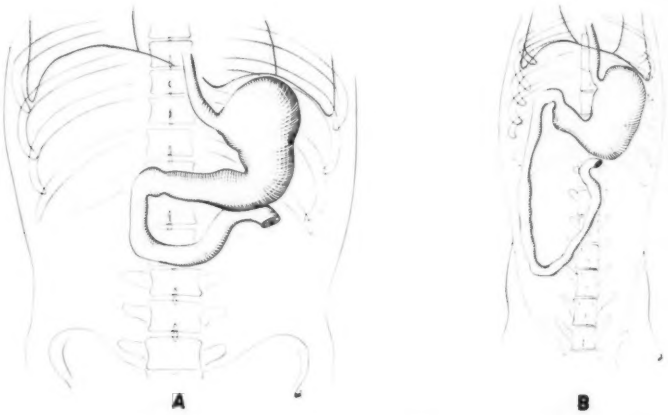


Fig. 2. A comparison of the gross external appearance of the stomach and duodenum in man and the dog. Note the cephalad angulation of the antrum in the dog, as well as the long descending duodenal loop. The gastric rugal folds, not illustrated, are grossly similar in man and the dog.

while at the end of twenty-four hours slightly more than half of the proximal small intestine showed obstructive distention. The average diameter of the ileal lumen just above the obstruction site in the six-hour studies was 11 mm., and in the twenty-four-hour studies 15 mm. In both instances the diameter distal to the obstruction averaged 4 mm., giving a rough ratio of 3:1 in the six-hour studies and 4:1 in the twenty-four-hour studies. A significant difference was noted in the viscosity of the contents of the dilated loops in the six- and twenty-four-hour observations. In none of the autopsy measurements was it possible to prove that the state of hydration, as herein defined, made any significant difference in the obstructive pattern. In the six-hour studies the findings were suggestive, however, of prominent circular folds in the mucosa of the distended jejunum of the dog, so that radiologically one cannot differentiate between distended loops of jejunum and ileum. With a little experience, however, one can, on radiographs of the dog's abdomen, frequently identify the colon, the coiled cecum, and the long duodenal loop. In erect films one may see two separate air-fluid levels in the stomach, one in the upper body and fundus and the other in the distal antrum. Basically, however, the radiologic diagnosis of mechanical small intestinal obstruction in the dog, as well as in the man, depends upon the recognition of selectively distended small-intestinal loops. From a practical standpoint this means that such loops must contain enough gas for their identification on routine radiographs, with or without enough fluid to

permit the formation of air-fluid levels.

There was radiographic evidence of mechanical small intestinal obstruction in 27 (90 per cent) of the 30 dogs followed for twenty-four hours, and the degree of hydration did not appear to influence significantly the radiographic appearance in any respect.

In the six-hour studies the ability to make a radiologic diagnosis of obstruction did seem to be influenced by the degree of hydration, the radiologic variation being much more impressive than the gross autopsy findings would indicate. Interestingly enough, however, the significant difference in the six-hour studies from the radiologic standpoint was not in the presence or number of air-fluid levels identified in relation to the degree of hydration, but rather in the identification of dilated gas-filled loops. In the dogs hydrated intravenously, distended gas-filled small-bowel loops were identified on 8 occasions, while in the dogs dehydrated for forty-eight hours the films revealed such dilated loops only 3 times.

Twenty-six of the 30 dogs used in the six-hour studies showed autopsy evidence of functional obstruction, but in only 16 (62 per cent) of these was there radiologic evidence of obstruction. It is thus apparent that the radiologic changes lag behind the actual pathological situation, especially in the early stages of the development of obstruction. Occasional instances were encountered, comparable to clinical obstructions, in which the radiographic appearance was normal in the presence of rather gross obstructive changes at autopsy. In such instances there was a paucity of gas in the obstructed loops, but large amounts of fluid were present.

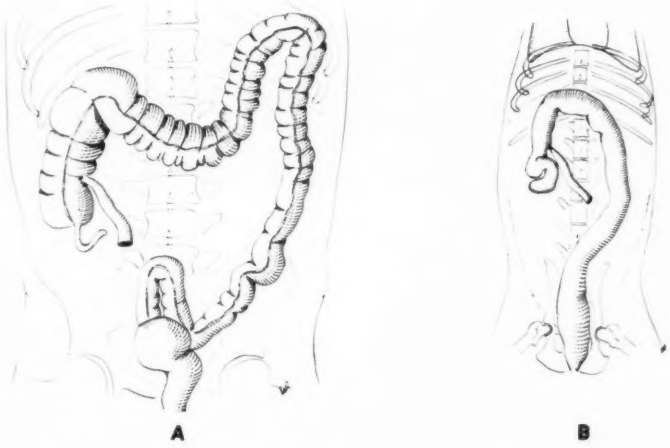


Fig. 3. A comparison of the gross external appearance of the colon in man and the dog. Note the short ascending and transverse portions of the colon in the dog (B), and the long straight descending colon. The coiled cecum and lack of haustrations along the course of the colon are also indicated, the latter being due to the fact that the dog has no taeniae coli.

SUMMARY

An experimental study is reported dealing with the gross pathologic and radiologic changes following the production of complete, non-strangulating obstruction in the distal ileum of 60 dogs, and an effort has been made to evaluate the importance of the state of hydration in the development of such changes. The stomach and small intestine were empty of food at the time of the production of the obstruction, and the animals were given nothing by mouth for six or twenty-four hours postoperatively, during which time functional changes

secondary to the obstruction were permitted to develop.

In 56 of the 60 animals, through a combination of their own body fluids, digestive tract secretions, and ingested air, typical mechanical obstructive changes were produced. On the basis of autopsy findings the state of hydration did not appear to influence markedly the patterns produced. Suggestive differences, however, were noted in the six-hour studies, especially from the radiographic standpoint. The ability to detect the presence of obstruction radiologically tended to lag behind the actual pathological situation, especially in the six-hour studies.

It is planned to use the findings in the present study as a base line for additional experiments in dogs which are well hydrated and, in addition, have been given fluids and food *per os* at the time of and prior to the production of similar obstructions.

REFERENCES

1. CARLSON, H. A., AND WANGENSTEEN, O. H.: Motor Activity of the Distal Bowel in Intestinal Obstruction; Comparison with the Obstructed and Normal. Proc. Soc. Exper. Biol. & Med. **27:** 676-681, April 1930.

2. CROWLEY, R. T., AND JOHNSTON, C. G.: Physiological Principles in Intestinal Obstruction. S. Clin. North America **26:** 1427–1439, December 1946.

3. FRIMANN-DAHL, J.: Experimental Ileus in Rabbits. Acta radiol. **35:** 101–114, February-March 1951.

4. HIBBARD, J. S.: Gaseous Distension Associated with Mechanical Obstruction of Intestine. Arch. Surg. **33:** 146–167, July 1936.

5. NEMIR, P., JR., AND HAWTHORNE, H. R.: Symposium on Applied Physiology in Modern Surgery. Surgical Physiology and Management of Acute Intestinal Obstruction. S. Clin. North America **35:** 1703-1717, December 1955.

6. SCOTT, H. G., DVORAK, H. J., BORMAN, C. N., AND WANGENSTEEN, O. H.: Comparative Study of Quantity of Gas in Bowel in Simple and Closed-Loop Obstruction. Proc. Soc. Exper. Biol. & Med. **28:** 902-904, June 1931.

7. WANGENSTEEN, O. H., AND REA, C. E.: Distention Factor in Simple Intestinal Obstruction. Experimental Study with Exclusion of Swallowed Air by Cervical Esophagostomy. Surgery **5:** 327–339, March 1939.

University of Mississippi Medical Center
Jackson, Miss.

SUMMARIO IN INTERLINGUA

Non-Strangulante Obstruction Ileal Distal

Parte I: Le Rolo de Hydratation. Un Studio Experimental de Correlation Inter le Constatationes Pathologic e Radiologic

Es reportate un studio experimental, concernite con le grossier alterationes pathologic e radiologic occurrente in consequentia del production de un complete non-strangulante obstruction in le ileum de 60 canes. Attention esseva prestate al evalutation del importantia del stato de hydratation in le disveloppamento de ille alterationes. Le stomacho e le intestino tenue esseva vacue de alimento al tempore del production del obstruction, e le animales ingereva nihil per via oral durante periodos de sex o vinti-quatro horas post le operation. Durante iste intervallo, le libere disveloppamento de alterations functional esseva permittite.

In 56 del 60 animales, gratias a un combination de lor liquidos corporee, del secretiones de lor vias digestive, e del aere ingerite per illos, typic alterationes mechanico-obstructive esseva producite. A judicar per le constatationes necroptic, le stato de hydratation non pareva exercer un grado marcate de influentia super le resultante configurationes. Tamen, differentias de valor suggestive esseva notate in le studios post intervallos de sex horas, particularmente ab le puncto de vista radiographic. Le possibilitate de deteger le presentia de obstruction per medios radiologic tendeva a relentar se in comparation con le evidentia del situation pathologic. Isto valeva particularmente in le studios post intervallos de sex horas.

Roentgen Examination of the Cecum and Proximal Ascending Colon with Ingested Barium[1]

E. ROBERT HEITZMAN, M.D., and ALFRED S. BERNE, M.D.

EXAMINATION of the cecum and the proximal ascending colon with ingested barium has received little mention in the radiological literature. Ross Golden has strongly recommended this type of investigation in studies of the cecum and the colon just distal to the ileocecal valve is the last portion of the colon to be filled, debris and fluid may occasionally be brought to it by the enema, from the distal colon. During filling of the proximal colon the patient may be uncomfortable and unco-operative, so that an adequate fluoroscopic spot-film study is hard to obtain (Fig. 1). On occasion, it is difficult to be certain that the cecum is filled by the enema. Since elucidation of the differential diagnosis of lesions in this region requires thorough study of the mucosa and of adjacent structures (the appendix and terminal ileum), a method which will allow meticulous filming and

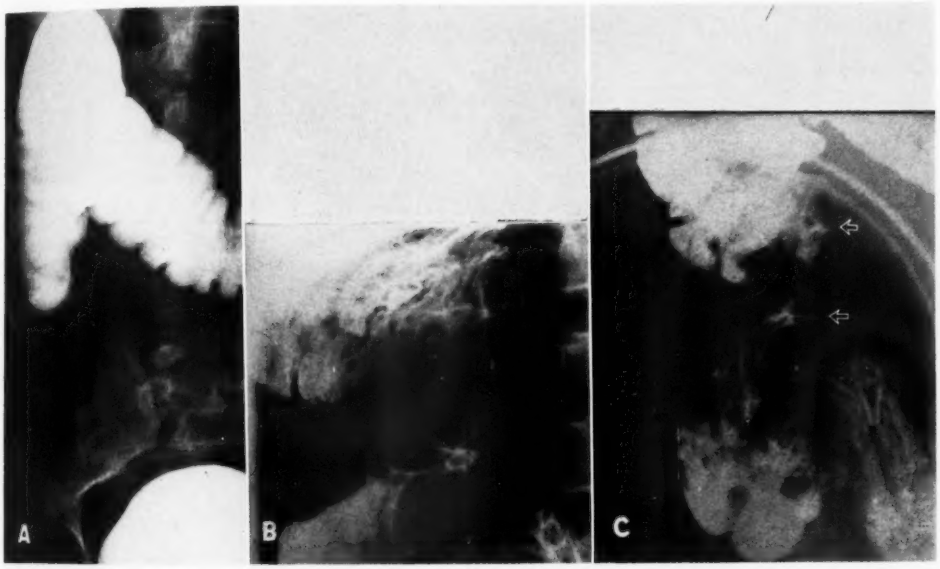


Fig. 1. C. S., a 62-year-old white man, was admitted with a three-month history of right lower quadrant pain associated with anorexia and a 14-pound weight loss. Two barium-enema examinations, including air-contrast studies, failed to fill the cecum adequately. A representative film from these studies is shown in A. Pressure spot-films, supine (B) and prone (C), demonstrate a plaque-like defect with sharp, fixed margins and mucosal destruction involving the medial wall of the ascending colon (arrows). A diagnosis of carcinoma was made and confirmed at surgery.

Comment: A small malignant lesion and definite mucosal destruction were established readily with pressure spot-films in this instance. The mucosal detail necessary for such a diagnosis may be difficult to obtain during a barium-enema examination.

(3, 4). Others have also mentioned that the procedure may often be worthwhile in evaluating the right colon (1, 2, 5). We have found it an extremely useful maneuver as an *adjunct* to the barium-enema study of the large intestine.

The cecum can be difficult to examine thoroughly by barium enema. Since it

[1] From the Radiological Services of the Syracuse Memorial Hospital and the Veterans Administration Hospital, Syracuse, N. Y., and the Radiology Department of the State University of New York, Upstate Medical Center, Syracuse, N. Y. Accepted for publication in September 1960.

fluoroscopic observation is valuable (Figs. 2 and 3). Further examination with oral barium is a simple additional procedure which usually solves the dilemma without discomfort to the patient (Fig. 2).

copy. Spot-films with and without pressure are readily made in the supine and prone positions (Figs. 1 and 4).

The relationships of the cecum to the appendix, terminal ileum, and ileocecal

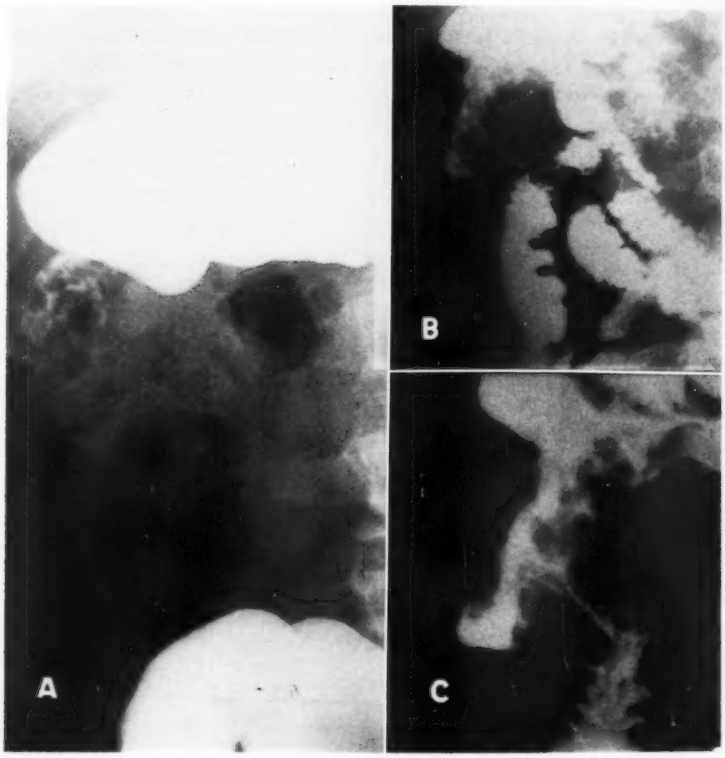


Fig. 2. L. J., a 39-year-old Negro, complained of right-sided abdominal pain of five days duration without diarrhea or melena. Despite two barium-enema examinations with air contrast, it was not possible to fill the cecum or terminal ileum, and a tentative diagnosis of carcinoma was entertained. A representative film from these studies is reproduced (A). Examination of the right colon with barium by mouth showed contraction of the cecum and ascending colon and outlined multiple polypoid mucosal defects (B and C). A radiologic diagnosis of an inflammatory process was made because of the contracted cecum and shortening of the ascending colon. Tuberculosis and amebiasis were suggested as possible causes. Pathological examination of the resected specimen showed nonspecific granulomatous inflammation of the right colon and appendix.

Comment: The diagnosis in this case rested on the demonstration of the proximal portion of the lesion and its relationship to the ileocecal valve. Neither of these points could be established with two barium-enema studies.

ADVANTAGES OF INGESTED BARIUM

The use of ingested barium for study of the proximal right colon has many advantages. The examination becomes a comfortable one for the patient and the radiologist is therefore able to study the lesion carefully and thoroughly at fluoros-

valve are easily demonstrable. Filling of the entire colon is assured, and the length of the right colon can be determined (Fig. 2). The ileocecal valve is easily identified and can be distinguished from a cecal abnormality (Fig. 4).

The proximal margin of a right-sided

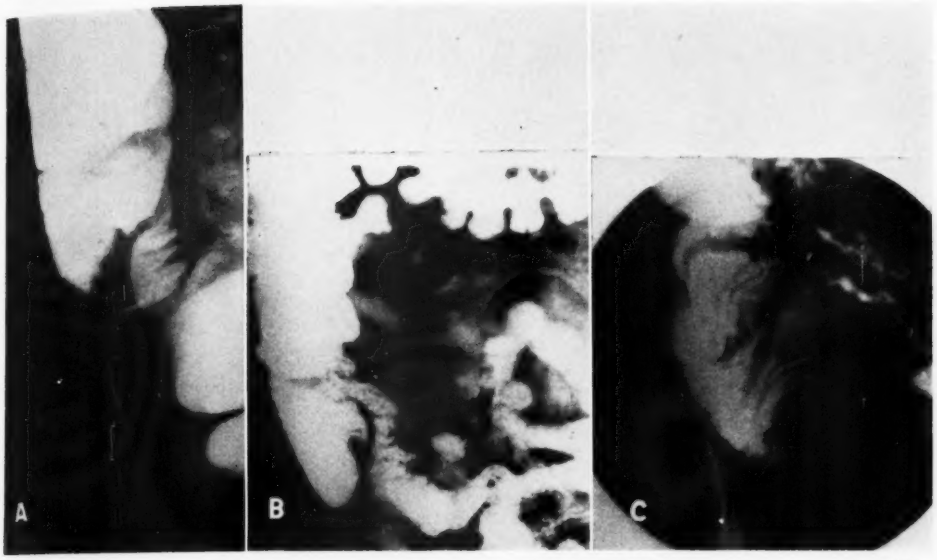


Fig. 3. L. D., a 57-year-old white woman, reported the onset of right lower quadrant pain, nausea, and vomiting ten days prior to admission. A slight ache in the right lower quadrant persisted, and minimal tenderness in the same area was noted. The temperature and blood counts were normal.

Barium-enema examination showed marked irregularity of the cecal tip (A). The appendix did not fill.

B. A spot-film of the right lower quadrant following barium ingestion does not demonstrate the mucosa or the true extent of the defect in the cecal apex.

C. A spot-film with pressure shows intact mucosa displaced by a smoothly lobulated extrinsic defect. A radiologic diagnosis of appendiceal abscess was made. The patient had an elective appendectomy six weeks following this examination. No abscess was found but there were adhesions binding the appendix to the cecum and to the posterior abdominal wall.

Comment: The fine mucosal detail shown by the oral barium method clarified an otherwise difficult differential diagnosis between intrinsic and extrinsic disease of the cecum.

colonic lesion, which produces obstruction to the retrograde flow of barium administered by enema, can be visualized (Fig. 2). Lesions of the colon in the vicinity of the ileocecal valve may obstruct the retrograde flow of barium but will not necessarily interfere with the antegrade flow. It is worthy of emphasis that the colonic contents in this region are liquid.

Adequate mucosal detail is more consistently demonstrated by this method than by the barium enema, for it is not uncommon that in the post-evacuation phase of the latter examination the mucosa of the proximal colon is not well delineated.

INDICATIONS

We have found that there are three distinct indications for oral ingestion of barium *after* the barium-enema study has been performed.

1. To confirm or exclude a questionable lesion discovered in the cecum or proximal ascending colon during barium-enema examination (Fig. 5).

2. To identify the cecum following an enema study in which it was not definitely filled. Certainty of complete cecal filling depends upon demonstration of the terminal ileum, the appendix, or an absolutely characteristic ileocecal valve (Fig. 6).

3. To allow detailed examination of a lesion in the cecum or proximal colon which has been identified during barium enema, thus permitting definitive diagnosis (Fig. 1).

CONTRAINDICATIONS

It should be emphasized that examination with oral ingestion of barium is never used initially in studying the colon but always follows a barium enema. If there is any suggestion of obstruction in

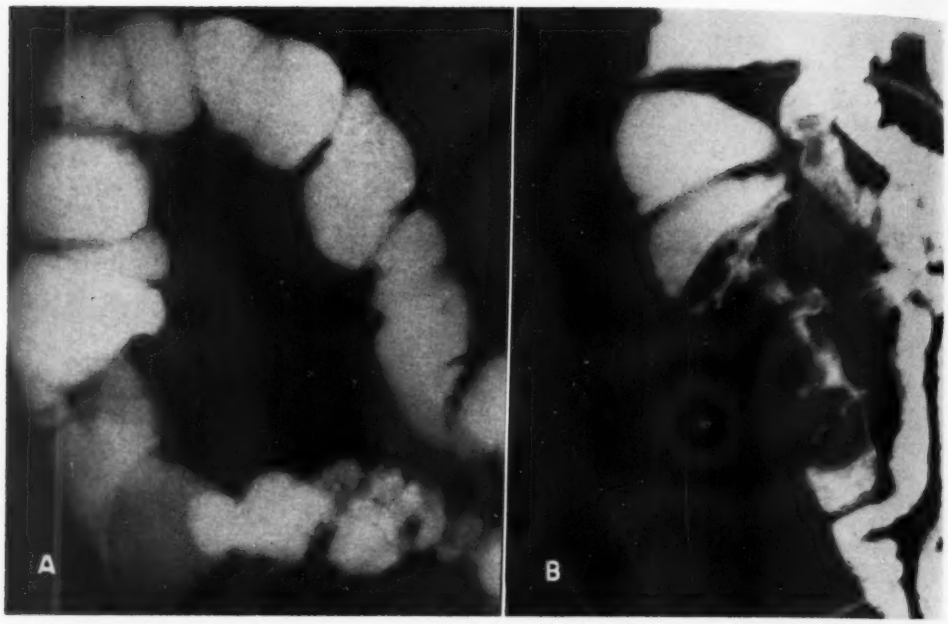


Fig. 4. B. P., a 78-year-old white woman, entered the hospital with severe anemia and a history of a 30-pound weight loss in eighteen months. She had no bowel symptoms but showed signs of chronic cholecystitis.
Barium-enema examination (A) shows a filling defect suggestive of an enlarged ileocecal valve.
A prone pressure spot-film following the ingestion of barium (B), however, reveals a mass in the region of the ileocecal valve with extensive mucosal destruction indicative of carcinoma.
Comment: This case illustrates the value of the oral ingestion of barium in differentiating malignant neoplasm from benign enlargement of the ileocecal valve.

the hepatic flexure or distally in the colon on plain film examination followed by barium enema, oral barium administration is contraindicated.

Another contraindication is x-ray evidence of small-intestinal obstruction or dilatation. In such a situation, fluid in the small intestine dilutes the barium, delays its passage, and prevents adequate visualization of the right colon. Under these circumstances we would pass a Miller-Abbott tube, decompress the small intestine, and then inject barium through the tube (6).

METHOD

1. The oral ileocecal study is *always* preceded by a complete barium-enema examination. An air-contrast study of the colon is performed routinely on all patients over forty years old but is not done on younger patients unless indicated clinically, *i.e.*, by polyp, bleeding, etc.

2. Preparation is similar to that for an upper gastrointestinal series. Nothing is allowed by mouth after midnight the night before the examination. No breakfast is given. Occasionally the patient is prepared as for a barium enema, with cathartics and enemas on the day before.

3. The patient is given 6 ounces of colloidal barium to be mixed with 6 ounces of tap water and taken at 6 A.M. on the day of the examination.

4. A plain film of the abdomen is made at 9 A.M. and is viewed by the radiologist. At this time, the ileocecal area will frequently be filled and the patient is immediately examined fluoroscopically. If the roentgenogram shows nonfilling or incomplete filling of the cecum, a food stimulus is given, such as cold milk, and a film is made thirty minutes later. The roentgenogram is again viewed promptly. In this manner films are taken until the ileocecal region is adequately filled.

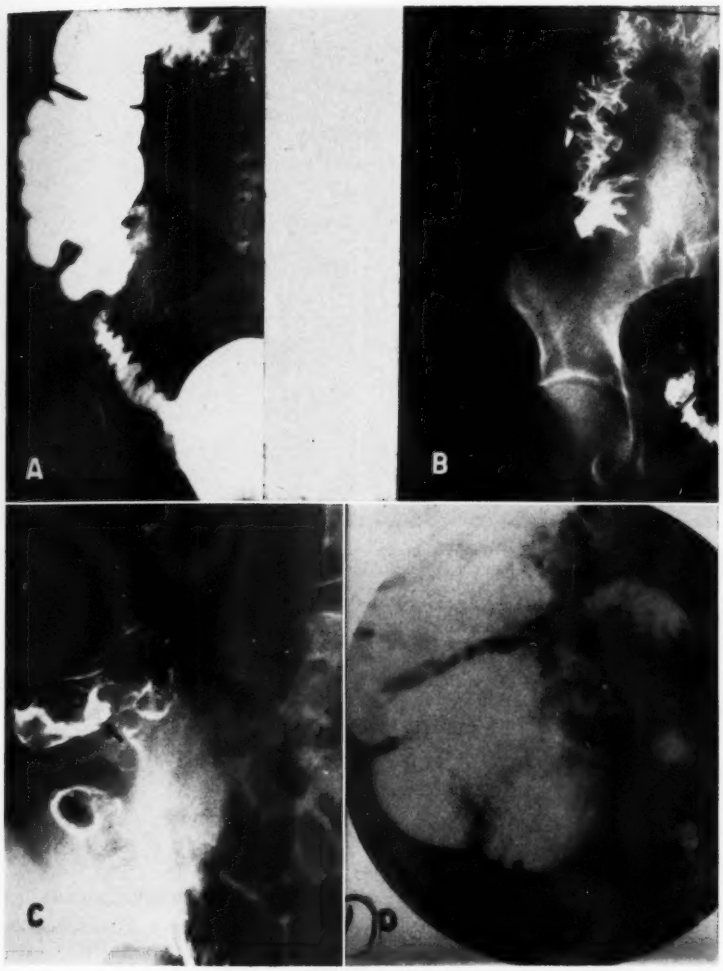


Fig. 5. H. Y., a 52-year-old white woman, had a five-year history of dull right lower quadrant pain. Physical examination was normal. On June 5, 1959, barium-enema and air-contrast studies were performed.

A, B, C. Representative barium-enema and air-contrast films show a small, deformed cecum. Nodularity of the caput cecum is suggested on the post-evacuation and air films (arrows).

D. A pressure film from the examination after barium ingestion demonstrates an entirely normal cecum.

An exploratory laparotomy, Sept. 22, showed adhesions about the left tube and ovary. Exploration of the right lower quadrant disclosed no abnormalities.

Comment: In this instance a normal ileocecal area was shown with oral barium after the barium-enema examination strongly suggested disease.

5. At fluoroscopy the patient is observed in the supine position and a spot-film is made without pressure to show the relationship of the terminal ileum to the cecum. Prone and supine spot-films are then made in varying degrees of obliquity, without pressure and with varying amounts of pressure, to show the cecum and proximal colon to best advantage.

At this point, if maximal cecal distention is desired, it is possible to inflate the barium-coated cecum with air introduced *per rectum* (Fig. 6).

It must be emphasized that care should

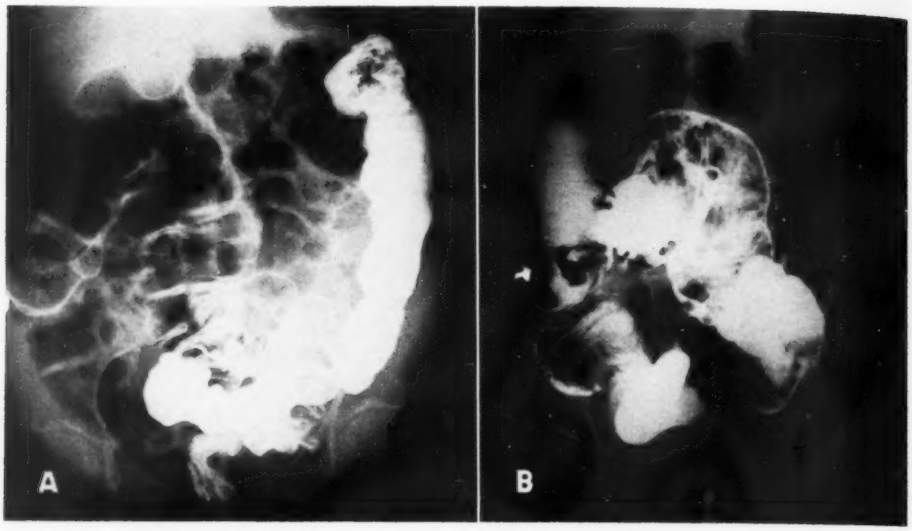


Fig. 6. E. B., a 55-year-old white woman, complained of abdominal bloating after eating and chronic constipation. A mass the size of a hen's egg was palpable in the right lower quadrant. The patient was moderately anemic.

A. A representative film from the double-contrast barium-enema study shows nonfilling of the cecum.

B. Oral barium examination plus air insufflation *per rectum* demonstrates annular narrowing of the ascending colon (arrows). Resection was performed for an annular carcinoma of the proximal ascending colon.

Comment: This case demonstrates the excellent delineation of a lesion in the proximal right colon with the oral method, following a block to the retrograde flow of barium introduced *per rectum*. In this instance some observers felt that the cecum was filled on the original examination. This consideration was disproved by oral administration of the medium.

be taken to be certain that the cecum is completely filled with barium before detailed fluoroscopic and spot-film analysis is undertaken. Positive and negative errors can be made on the basis of an examination of an incompletely filled cecum and proximal right colon.

SUMMARY

The value of the oral administration of barium for study of the cecum and proximal right colon has been re-emphasized. Our method of carrying out this procedure has been given in detail. Several illustrative cases are reported, demonstrating the great value of this procedure as an adjunct to the barium-enema examination of the proximal colon and cecum.

820 S. Crouse Ave.
Syracuse 10, N. Y.

REFERENCES

1. BERANBAUM, S. L., AND SUBBARAO, K.: Normal Ileo-Cecal Valve. Am. J. Digest Dis. **22**: 254–261, September 1955.

2. BOCKUS, H. L., ET AL: Gastro-Enterology. Vol. II. Philadelphia, W. B. Saunders Co., 1944.

3. GOLDEN, R.: Radiologic Examination of the Small Intestine. Springfield, Ill., Charles C Thomas, 2d ed., 1959.

4. GOLDEN, R., AND DUCHARME, P.: The Clinical Significance of Deformity of the Cecum in Amebiasis. Radiology **45**: 565–580, December 1945.

5. GOTTLIEB, C., BERANBAUM, S. L., AND DORFMAN, M.: Roentgen Features of Non-Malignant Periappendiceal and Ileo-Cecal Lesions. Am. J. Digest. Dis. **18**: 79–86, March 1951.

6. SCHATZKI, R.: Small Intestine Enema. Am. J. Roentgenol. **50**: 743–750, December 1943.

SUMMARIO IN INTERLINGUA

Le Roentgeno-Examine del Ceco e del Colon Ascendente Proximal post Ingestion de Barium

Le utilitate del administration oral de barium pro le studio del ceco a del colon dextere proximal es re-sublineate. Plure casos illustrative es presentate pro demonstrar le valor del manovra como adjuncto al examine post clyster de barium.

Le examine es confortabile ab le puncto de vista del patiente. Le relation inter ceco e appendice, ileum terminal, e valvula ileo-cecal es facilemente demonstrabile. Le margine proximal de un lesion colonic al latere dextere (que resultarea in le obstruction del fluxo retrograde de barium administrate in forma de clyster) pote esser visualisate. Adequate detalios mucosal es demonstrabile plus uniformemente que in studios a clyster de barium.

Le methodo se usa exclusivemente post (nunquam ante) le effectuation de un studio a barium per clyster, e illo non es empleate in le presentia de provas roentgenologic de (1) obstruction in le flexura hepatic o in sito distal a illo in le colon o (2) obstruction o dilatation del intestino tenue.

Le detalios del methodo es presentate.

Palliation of Osseous Metastases from Breast Carcinoma with Radioactive Phosphorus Alone and in Combination with Adrenalectomy[1]

JOHN P. STORAASLI, M.D., RICHARD L. KING, M.D., HARVEY KRIEGER, M.D., WILLIAM E. ABBOTT, M.D., and HYMER L. FRIEDELL, M.D.

THE PALLIATION of metastasizing carcinoma of the breast presents a tremendous problem to the clinician. Several therapeutic approaches have been proposed. Just before the turn of the century Schinzinger (12) and Beatson (1) showed that oophorectomy produced beneficial effects in premenopausal patients. In 1939 Ulrich (13) and Loeser (8) demonstrated that testosterone was beneficial in the palliation of bone metastases, and in 1944 estrogen was first used in postmenopausal women with metastases from carcinoma of the breast.

Irradiation is the treatment of choice for local recurrences of mammary cancer and for isolated bone metastases. In almost every case, however, the disease eventually becomes so widespread that external radiation therapy is no longer practical.

In 1950, two of the present authors (4) reported on the use of radioactive phosphorus for the treatment of widespread osseous metastases from carcinoma of the breast. They obtained subjective relief of pain in approximately three-fourths of the patients. In addition to this, serial roentgenographic examinations revealed objective evidence of healing of metastatic bone lesions in a small number of cases. Recently Maxfield *et al.* (10) reported beneficial results with radioactive phosphorus in combination with testosterone.

In 1952, Huggins and Bergenstal (6) demonstrated that bilateral adrenalectomy was effective in the palliation of metastasis from carcinoma of the breast. Since that time, many reports have substantiated their conclusions. Palliation was obtained in approximately 40 per cent of the patients and seemed to be most efficacious in those with primarily osseous metastases.

Since either radioactive phosphorus or bilateral adrenalectomy is of benefit in the palliation of osseous metastases, the authors decided to combine the procedures in the hope that this approach would be more effective than either treatment alone. This article is a report of experience with 64 patients treated with radioactive phosphorus alone or in combination with bilateral adrenalectomy.

THE RATIONALE FOR THE USE OF RADIOACTIVE PHOSPHORUS

The use of radioactive phosphorus in the treatment of widespread bone metastases is supported by several observations. In comparisons of rapidly growing or embryonic tissues with those which have attained the normal adult state, a definite differential absorption rate of diffusible phosphorus has been established. Marshak (9) has shown that malignant tumor cells accumulate more radioactive phosphorus than normal cells and that their nuclei contain greater quantities of the radioactive element than do the nuclei of normal cells. Forssberg and Jacobsson (2) demonstrated that metastatic tumor nodules of transplanted Brown-Pearce tumors accumulated more radioactive phosphorus than the most active normal tissues.

Since bone contains more phosphorus than any other tissue, a major fraction of an administered dose of radioactive phosphorus ultimately accumulates in the skeletal system. Forssberg (3) found that

[1] From the Departments of Radiology and Surgery, Western Reserve University and University Hospitals of Cleveland, Cleveland, Ohio. Presented at the Forty-sixth Annual Meeting of the Radiological Society of North America, Cincinnati, Ohio, Dec. 4–9, 1960.

bone metastases take up considerably larger amounts of radioactive phosphorus than corresponding wet weights of normal bone. These observations are substantiated by radioautographs (4, 10). Also, Greenberg *et al.* (5) demonstrated with external counting technics an increase in the accretion rate of calcium 47 in new bone formation in areas within and adjacent to bone metastases from breast carcinoma.

The rationale of using radioactive phosphorus in conjunction with bilateral adrenalectomy was the anticipation of objective benefit derived from the surgical procedure. If healing of osseous metastases were to occur from the adrenalectomy, it would seem most beneficial to give the isotope during this phase. Recalcification of osteolytic lesions would be associated with an increased deposition of phosphorus as a calcium salt. There is evidence to support this conclusion in the report by Krieger *et al.* (7).

METHOD

All patients had complete physical examinations and roentgenographic bone surveys to determine the extent of disease and for purposes of comparison with post-therapy roentgenograms. Complete blood counts were obtained, since the total dose of radioactive phosphorus is ultimately defined by the hematologic depression observed. In most instances, determinations were made of serum calcium, phosphorus, and alkaline phosphatases. Metabolic balance studies (calcium, phosphorus, and nitrogen) were done in patients undergoing bilateral adrenalectomy before and after surgery.

Although the treatment schedule was not rigidly fixed, the usual course was as follows. Radioactive phosphorus in 2.0-millicurie doses was administered intravenously at five- to six-day intervals. Blood counts were obtained before each dose in order to detect any depression of the hematopoietic system. Treatment was discontinued when the white blood cell count fell below 2,000 or the platelet count was below 50,000 per cubic millimeter. To produce these effects, total doses ranging from 16 to 22 millicuries were required (Fig. 1). The total treatment course with P^{32} required about five to six weeks.

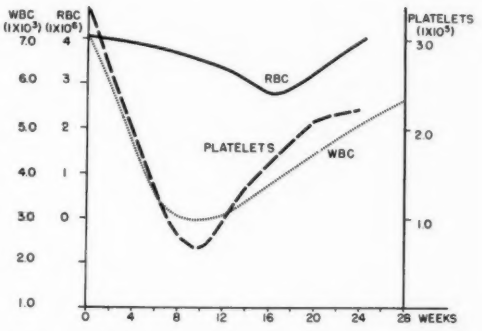


Fig. 1. Dose response curves: Peripheral blood indices in 64 patients with breast cancer metastases treated with P^{32}.

When the radioactive phosphorus was given after adrenalectomy, an interval of ten to fourteen days was allowed between the two procedures.

RESULTS

Since 1948, a total of 64 patients have been treated with radioactive phosphorus. In all of these evidence of progression of the osseous metastases was demonstrated on roentgenographic examinations, and in all one or more palliative measures had been used, such as oophorectomy, hormonal therapy, and extensive irradiation. Forty-two patients were treated with P^{32} alone. In the remaining 22 cases, radioactive phosphorus was administered following bilateral adrenalectomy.

In the evaluation of a new therapeutic measure, it is important to have standard and objective criteria upon which the results may be judged, so that the reader clearly understands the conclusions presented. It is difficult to weigh the relief of symptoms such as pain, anorexia, and malaise that are so frequently encountered in patients with metastatic carcinoma. These, therefore, were excluded in the evaluation. The only criteria we used were: (*a*) *evidence of recalcification of bone*

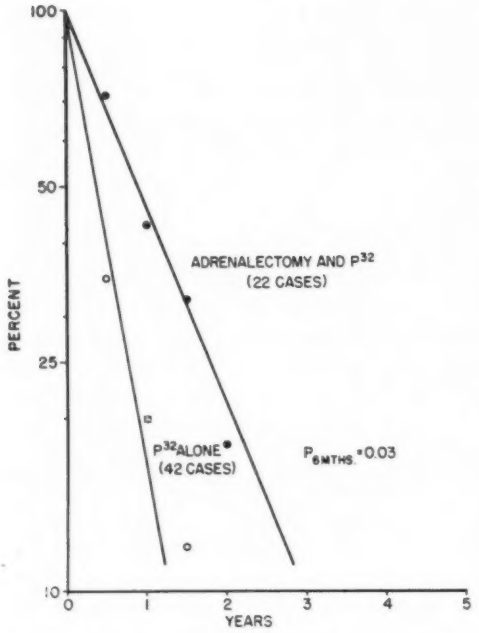


Fig. 2. Survival curves after therapy in metastases from carcinoma of the breast (64 cases).

metastases and (*b*) *survival for longer than six months after completion of treatment.* It is of interest to note that all of the patients with objective improvement also received marked amelioration of pain associated with an increase in appetite, weight, and ambulation. In fact, subjective improvement was experienced in many cases which were deemed treatment failures because of lack of objective evidence of success. These observations should be looked upon with optimism when one considers the type of patients treated, for many of them had far-advanced disease, were completely bedridden, and required large doses of narcotics.

When radioactive phosphorus was used alone, approximately 26 per cent (11 of 42 cases) of the patients showed objective evidence of improvement (Table I). Although the number of patients in the group is small, the most impressive results were achieved with the combination of bilateral adrenalectomy and radioactive phosphorus. In this group, good results were obtained in 68 per cent (15 of 22 cases). According to the literature, definite improvement can be anticipated following adrenalectomy in approximately 40 per cent of the patients. The use of radioactive phosphorus in adrenalectomized patients appears to increase the beneficial results by an additional 25 per cent.

Figures 3 and 4 show patients who responded well to radioactive phosphorus alone. Figures 5–7 are illustrations of patients in whom improvement was obtained by bilateral adrenalectomy followed by a course of P^{32}.

To evaluate the results of treatment, one of the most important criteria would

TABLE I: RESULTS OF TREATMENT

	P^{32} Alone (42 Cases)		Adrenalectomy and P^{32} (22 Cases)	
	Good	Poor	Good	Poor
Results	11 (26%)	31 (74%)	15 (68%)	7 (32%)
Age (years)	49.6	50.1	51.6	46.4
Dose of P^{32} (Average in millicuries)	16.5	16.4	17.8	17.6
	Average Duration and Range (Months)			
Remission	10 (6–18)	0	15.5† (6–40)	0
Primary to bone metastases	35.8 (14–60)	39 (17–132)	30.6 (3–60)	32 (12–77)
Bone metastases to therapy	6.7 (1–35)	9.8 (1–48)	8.7 (1–30)	13 (6–24)
Therapy to demise	16* (6–50)	3.7 (1–17)	18† (6–48)	5.5 (3–13)

* One patient living (12 months) with progression of disease.
† Five patients living without progression 8, 22, 23, 24, and 40 months.

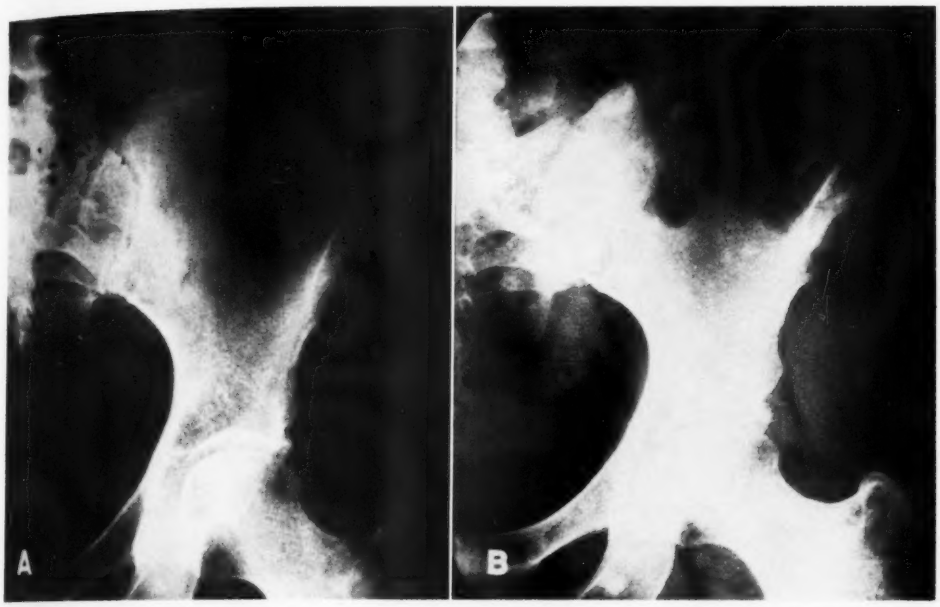


Fig. 3. A. Roentgenogram of the left pelvis of a 49-year-old female prior to treatment. Only two osteolytic metastases were seen in the ilium.
B. Follow-up roentgenogram one year after a course of P^{32}. Numerous areas of sclerosis are visible, signifying healed lesions.

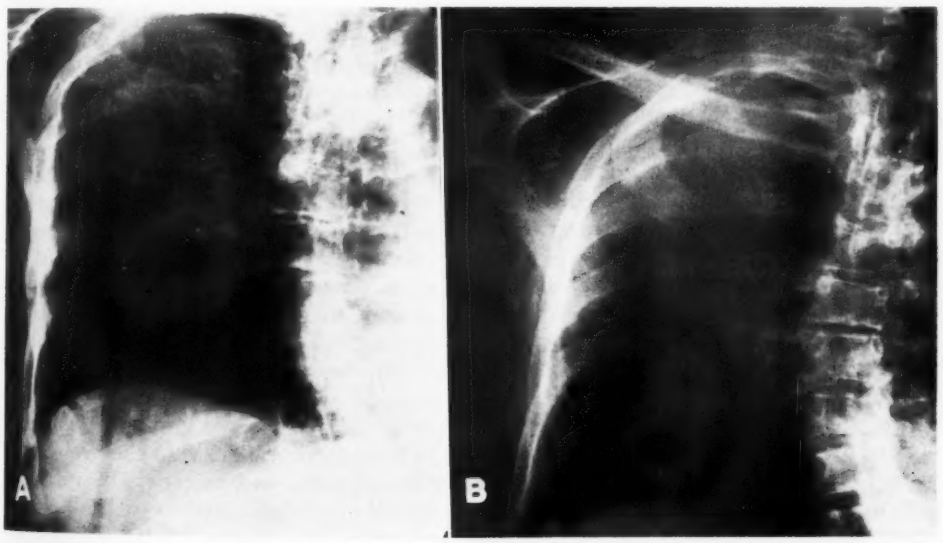


Fig. 4. A. Roentgenogram of right rib cage in an 81-year-old female prior to treatment, showing numerous osteolytic metastases with fractures.
B. Follow-up roentgenogram seven months after a course of P^{32} showing healing by new bone formation.

be the length of remission (recalcification and no progression of osseous lesions). There appears to be a difference in the average duration of remission in patients treated with P^{32} alone in comparison with those treated by adrenalectomy and P^{32}. From Table I it is seen that those who experienced a good response to radioactive

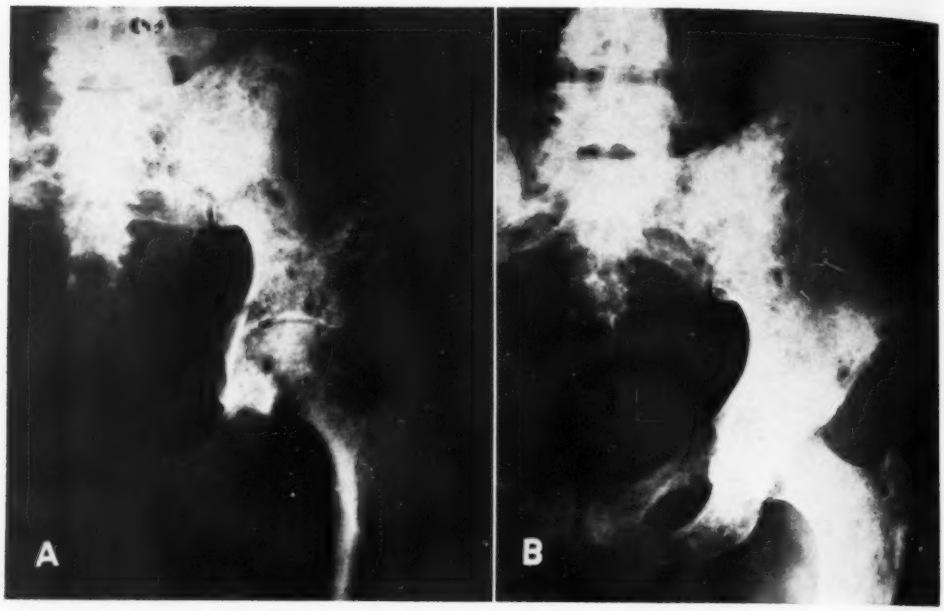


Fig. 5. A. Roentgenogram made prior to treatment in a 50-year-old female showing extensive osteolytic involvement of the pelvis and upper end of the femur.
B. Follow-up roentgenograms obtained seven months after bilateral adrenalectomy and P^{32} demonstrating new bone formation about all of the lesions.

phosphorus had an average remission of ten months, with a range from six to eighteen months. The average remission in those treated by the combined approach was fifteen and a half months and the range was from six to forty months.

There was little difference in the average duration of life following the two treatment methods. Those patients who responded to P^{32} lived an average of sixteen months, while those who responded to adrenalectomy plus P^{32} survived for an average of eighteen months. More important, however, is the fact that the combined therapeutic approach benefited a much greater portion of patients. Five who were treated by adrenalectomy and P^{32} are still living without progression eight, twenty-two, twenty-three, twenty-four, and forty months, respectively. Patients in both groups who failed to respond to treatment lived an average of four to five months.

Figure 2 shows the survival rate of the two groups of patients. From this curve there is an apparent increase in survival rate in those patients treated by adrenalectomy and radioactive phosphorus.[2] The significance of this data is not certain, since differences in population and selection of cases always exist. It can be noted from Table I, however, that there was no difference in the time between the diagnosis of carcinoma to the onset of bone metastases nor was there any difference in the interval between the onset of bone metastases to treatment by either method. The difference in age distribution of the two populations is also statistically insignificant. These facts would seem to indicate that the two groups are as similar as is possible considering the problems of management and selection of treatment regimes for these patients. While we do not wish to suggest that our data are completely meaningful, a trend appears to be present, even though the number of patients in each group is small and selection was not unbiased.

[2] Statistical analysis of this curve reveals a P value of 0.03 at six months.

DISCUSSION

Complications encountered from the administration of radioactive phosphorus concern the hematopoietic system. While in several instances the white blood count fell to levels of 1,000 to 1,500 cells per cubic millimeter and platelets to levels of about 30,000 to 40,000 per cubic millimeter, serious hematopoietic complications were not common. Petechiae and ecchymoses occurred in many patients when the platelet counts were severely depressed but disappeared promptly after cessation of therapy. Transfusions were occasionally necessary but were usually required because of the myelophthisic type of anemia associated with bone metastases rather than as a result of the radioactive phosphorus therapy. The average hematopoietic response is illustrated in Figure 1. One patient died of an intracerebral hemorrhage during the period of maximum bone marrow depression. Two other patients who were treated by adrenalectomy and radiophosphorus died of overwhelming afebrile infections. In each instance there was a definite depression of the hematopoietic system but the infection was masked by the administration of cortisone. With the use of antibiotics during the period of severe bone marrow depression this complication might have been avoided. There were 2 patients with apparent hemolytic anemias. In both instances, the hemolytic process disappeared during the radioactive phosphorus treatment, and no further blood transfusions were necessary.

Selection of patients who would uniformly respond to the combination of adrenalectomy and radioactive phosphorus is an important consideration. If only those who have previously responded to oophorectomy are selected, an increase in benefit can be expected from other hormonal manipulations such as bilateral adrenalectomy and hypophysectomy (11). However, there are a number of menopausal and post-menopausal patients who have responded to adrenalectomy and

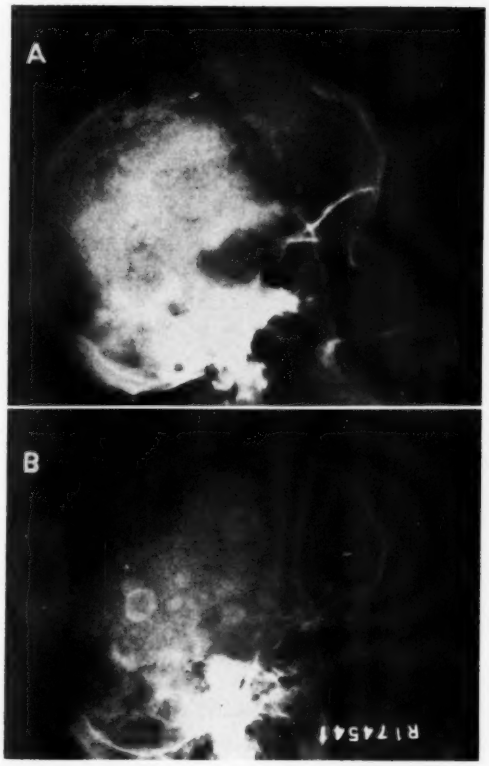


Fig. 6. A. Roentgenogram of the skull of a 64-year-old female, showing many osteolytic metastases.
B. Roentgenogram made eight months after treatment by bilateral adrenalectomy and P^{32}, showing healing by new bone formation.

P^{32}. Therefore, it is difficult to withhold this surgical procedure with or without radioactive phosphorus from any patient with bone metastases. From our experience, the best results are obtained in patients having predominant osseous metastases without evidence of extensive soft-tissue lesions involving vital organs such as liver, lung, and brain. If patients with extensive soft-tissue disease were eliminated from our study, the success rate would be much higher. It is of interest that 7 patients were found at surgery to have metastatic carcinoma in the adrenal glands, and 4 of these responded well to adrenalectomy plus P^{32}.

We believe that patients with hormone-dependent tumors, who are in negative

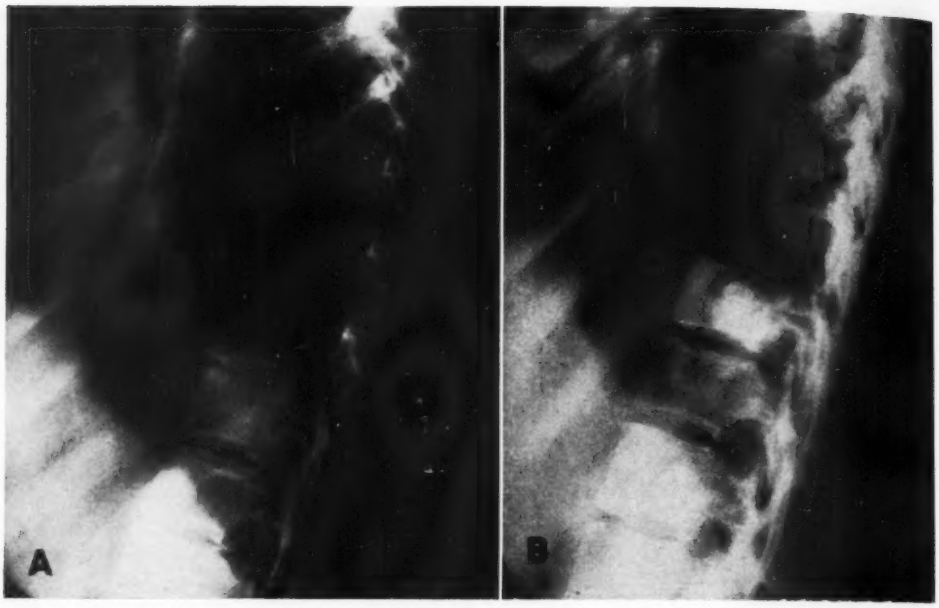


Fig. 7. A. Roentgenograms in a 40-year-old female showing osteolytic metastases in the spine.
B. Roentgenograms made five months after treatment by bilateral adrenalectomy and P^{32}, showing sclerosis and healing of many lesions that were not visible at the pretreatment examination.

calcium balance before adrenalectomy, have the greatest chance of responding to the combined approach utilizing radioactive phosphorus (7). It is well established that, during periods of extensive bone destruction, there is a negative phosphorus balance as well as a negative calcium balance. While both ions are retained during the healing and recalcification of bone, one would expect a greater selective uptake of P^{32} in the region of the osseous metastases, particularly when the regrowth of bone is occurring. In treating patients with radioactive phosphorus, it is important therefore to institute the isotope therapy within two weeks to one month after the surgical procedure to encompass the period of maximum positive calcium and phosphorus balance.

When benefits are obtained by radioactive phosphorus alone or in combination with bilateral adrenalectomy, healing of osseous metastases can be demonstrated roentgenographically approximately two-thirds of the way through the course of therapy. The most marked effect on bone healing is usually seen three to four weeks after the therapy has been completed. Subsequent roentgenograms often demonstrate many areas of sclerosis, signifying metastatic lesions that were not detected on the original survey study (Figs. 3 and 6).

Maxfield and his group have shown similar results with the use of testosterone and radioactive phosphorus (10). In a series of 137 cases with bone metastases from breast carcinoma, good results by our criteria were obtained in about 50 per cent of the cases.

Pearson and Ray (11) have demonstrated that hypophysectomy is beneficial in approximately 50 per cent of the patients with advanced breast carcinoma metastasizing predominantly to bone. Although the number of cases in our series of adrenalectomy and P^{32} is small, the results would appear to be at least as good or better. Whether the use of this isotope in combination with hypophysectomy would yield further improvement is not

known. This approach is now under consideration. Pearson and his group (5) have also shown that there is an increase of several-fold in the deposition of radioactive calcium 47 within and adjacent to bone metastases. This isotope, with its convenient half-life of 4.7 days, might be used therapeutically either alone or in combination with radioactive phosphorus. Radioactive calcium has great affinity for the skeletal system and may have an advantage over radiophosphorus, since the ratio of bone tumor dose to total body dose will be greater. On the other hand, phosphorus, in addition to its bone-seeking properties, has the advantage of being selectively deposited within the malignant tissue.

SUMMARY

Sixty-four patients with extensive osseous metastases from carcinoma of the breast were treated with radioactive phosphorus. Forty-two cases were treated with P^{32} alone and objective benefit was obtained in 26 per cent. Twenty-two cases were treated by bilateral adrenalectomy and radioactive phosphorus and objective benefit was obtained in 68 per cent.

Adrenalectomy alone yields good palliation in approximately 40 per cent of the patients treated. It appears that the addition of radioactive phosphorus therapy increases the proportion of patients responding to treatment.

Patients in negative calcium and phosphorus balance with predominantly osseous metastases which are known to be hormonally dependent have the greatest chance of responding to bilateral adrenalectomy and P^{32}.

University Hospitals of Cleveland
2065 Adelbert Road
Cleveland 6, Ohio

REFERENCES

1. BEATSON, G. T.: On the Treatment of Inoperable Cases of Carcinoma of the Mamma: Suggestions for a New Method of Treatment with Illustrative Cases. Lancet **2**: 104, 1896.

2. FORSSBERG, A., AND JACOBSSON, F.: Studies on the Brown-Pearce Rabbit-Carcinoma with the Aid of Radioactive Isotopes. Acta radiol. **26**: 523–534, 1945.

3. FORSSBERG, A.: A Study of the Distribution of Radioactive Phosphorus in Three Cases of Cancer. Acta radiol. **27**: 88–92, 1946.

4. FRIEDELL, H. L., AND STORAASLI, J. P.: The Use of Radioactive Phosphorus in the Treatment of Carcinoma of the Breast with Widespread Metastases to Bone. Am. J. Roentgenol. **64**: 559–574, October 1950.

5. GREENBERG, E., PAZIANOS, A. G., COREY, K. R., KENNEY, P., LAUGHLIN, J. S., AND PEARSON, O. H.: Calcium 47 Tracer Studies in Patients with Bone Lesions. Cancer. In press.

6. HUGGINS, C., AND BERGENSTAL, D. M.: Inhibition of Human Mammary and Prostatic Cancers by Adrenalectomy. Cancer Res. **12**: 134–141, February 1952.

7. KRIEGER, H., ABBOTT, W. E., STORAASLI, J. P., AND FRIEDELL, H. L.: Combined Therapy for Palliation of Metastatic Carcinoma of the Breast. Bull Soc. internat. de chir. **19**: 515-523, October 1960.

8. LOESER, A. A.: Male Hormone in Treatment of Cancer of the Breast. Acta Union internat. contre cancer **4**: 375–376, 1939.

9. MARSHAK, A.: Uptake of Radioactive Phosphorus by Nuclei of Liver and Tumors. Science **92**: 460–461, Nov. 15, 1940.

10. MAXFIELD, J. R., JR., MAXFIELD, J. G. S., AND MAXFIELD, W. S.: The Use of Radioactive Phosphorus and Testosterone in Metastatic Bone Lesions from Breast and Prostate. South. M. J. **51**: 320–327, March 1958.

11. PEARSON, O. H., AND RAY, B. S.: Hypophysectomy in the Treatment of Metastatic Mammary Cancer. Am. J. Surg. **99**: 544–552, April 1960.

12. SCHINZINGER: Combined Therapy for Palliation of Metastatic Carcinoma of the Breast. Centralbl. f. Chir. **16** (29. Beilage): 55, 1889.

13. ULRICH, P.: Testostérone (hormone mâle) et son rôle possible dans le traitement de certains cancers du sein. Acta Union internat. contre cancer **4**: 377–380, 1939.

(*Pro le summario in interlingua, vider le pagina sequente*)

SUMMARIO IN INTERLINGUA

Palliation de Metastases Ossee ab Carcinoma Mammari, per Medio de Phosphoro Radioactive, Sol o in Combination con Adrenalectomia

Viste que il ha essite demonstrate que, de un latere, phosphoro radioactive (P^{32}) e, del altere latere, adrenalectomia bilateral exerce effectos benefic in le palliation de metastases ossee ab cancere mammari, le spero pareva justificate que un combination del duo methodos esserea plus efficace que le un o le altere sol. Pro evalutar le effecto de iste combination therapeutic, 64 patientes con morbo metastatic de osso, secundari a carcinoma mammari, esseva tractate con P^{32}. In 22 del casos, iste tractamento sequeva adrenalectomia bilateral post intervallos de inter dece e dece-quatro dies.

In le gruppo tractate con le isotopo sol, 26 pro cento del casos manifestava beneficios objective. In le gruppo recipiente le therapia combinate, 69 pro cento del casos manifestava beneficios objective. Esseva previemente monstrate que adrenalectomia sol produce bon grados de palliation in 40 pro cento del casos assi tractate. Ergo il es permittite asserer que le combination de adrenalectomia con P^{32} augmenta le proportion del patientes qui responde favorabilemente al therapia.

Es opinate que patientes in balancias negative de calcium e de phosphoro e con metastases predominantemente ossee (que depende cognoscitemente del economia hormonal) es le plus apte a responder favorabilemente a adrenalectomia bilateral in combination con P^{32}.

Afterloading Technic with Rigid Needles in Interstitial Radiation Therapy[1]

HERMAN D. SUIT, M.D., ROBERT J. SHALEK, Ph.D., E. B. MOORE, B.S., and J. ROBERT ANDREWS, M.D.[2]

INTERSTITIAL radiation therapy is a frequently employed modality for cancer of the head and neck and the breast and chest-wall areas. Standard technics call for preloaded rigid needles containing radium or cobalt 60. Several difficulties, however, are inherent in the use of these preloaded source holders. To overcome these difficulties, at least partially, a technic for loading radiation sources into hollow stainless steel needles after their implantation (afterloading) is now under development. The aim has been fourfold:

(*a*) To increase the facility and accuracy of the needle implantation technic. If radiation exposure is eliminated during placement of the needles, unhurried attention may be given to obtaining an excellent source distribution, with repositioning of needles as required.

(*b*) To reduce radiation exposure to all persons concerned with patients receiving interstitial therapy, *i.e.*, the radiation therapists, the radium custodian, the operating room, recovery room, and ward nursing staffs, the diagnostic x-ray technical staff, the radiation physicist who calibrates and maintains the inventory of sources.

(*c*) To design needles for ease of source insertion, reduction of tissue trauma, and convenience of handling during implantation in the tissue.

(*d*) To develop new implant designs, permitted first by an increase in selection of needle lengths and shapes; second by a choice of positioning of the radiation sources along the needle length.

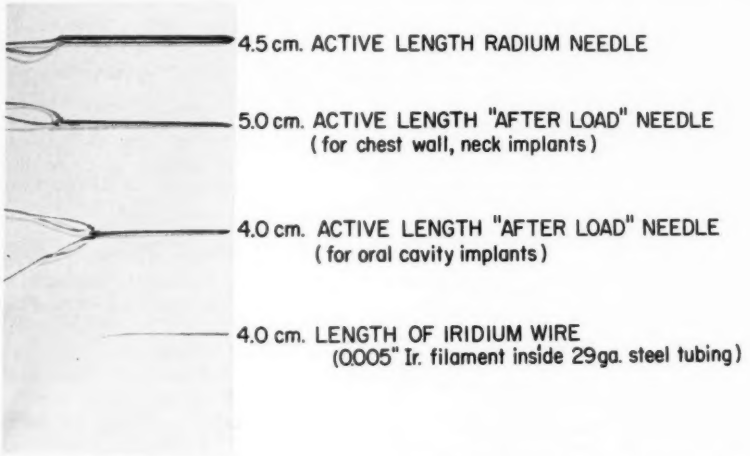

4.5 cm. ACTIVE LENGTH RADIUM NEEDLE
5.0 cm. ACTIVE LENGTH "AFTER LOAD" NEEDLE
(for chest wall, neck implants)
4.0 cm. ACTIVE LENGTH "AFTER LOAD" NEEDLE
(for oral cavity implants)
4.0 cm. LENGTH OF IRIDIUM WIRE
(0005" Ir. filament inside 29ga. steel tubing)

Fig. 1. Comparison of standard radium needles and stainless steel needles designed for afterloading.

TECHNIC

Needles: The two needle designs in current use are shown in Figure 1. For intra-oral implants, where loading of posterior needles is difficult, a special needle

[1] From the University of Texas M.D. Anderson Hospital and Tumor Institute (H.D.S., Department of Radiology; R. J. S. and E. B. M., Department of Physics), Houston, Texas. Presented at the Forty-sixth Annual Meeting of the Radiological Society of North America, Cincinnati, Ohio, Dec. 4–9, 1960.

[2] Chief, Radiation Branch, National Cancer Institute, Bethesda, Md.

head is constructed so that there is a funnel leading to the shaft. The needles for chest-wall and neck areas are lengths of stainless steel tubing with a point cut on one end and crimping just above the point. The opposite end is slightly flared to facilitate insertion of the wire. For these simple needles, sutures are not threaded through an eyelet; a ligature is placed just below the head or flared end and is fixed to the steel tubing by a drop of Eastman 910 bonding agent.

Radiation Source: Except for the use of cobalt-60 wires in 3 cases, iridium-192 wires have served as the radiation sources. These were generously provided by Dr. Ulrich K. Henschke. The iridium is in the form of an iridium-platinum alloy in a filament 0.005 inch in diameter. This filament is fixed in a stainless steel tube with an outside diameter of 0.012 inch. The inside diameter of the steel tubing in the needle is 0.023 inch, thus permitting easy insertion and removal of the sources. Iridium 192 is an artificial radioactive isotope with a half-life of 74.5 days, a mean effective gamma energy of 0.4 Mev (Wilson), and a maximum beta energy of 0.66 Mev (Strominger, *et al.*). The beta particles are effectively shielded by the steel cases. Protection against the gamma rays is more easily achieved by lead shielding than for radium gamma rays: h.v.l. 4 mm. lead for iridium *vs.* 13 mm. lead for radium (Price, Horton, and Spinney).

Loading and Unloading of Needles: After the implant is finished and localizing films are completed, the wires are inserted into the needles. To prevent slipping of the wire, a drop of collodion or cement is applied over the open end of the needle. After removal from the patient, the needles are allowed to stand in acetone overnight. This removes the collodion or cement, and the wires may then be shaken out.

Dose Calculation: Wires are calibrated by comparison with radium standards in an ionization instrument. Their activity is expressed as milligram-equivalents of radium and they are thereafter treated as linear radium sources in calculation.

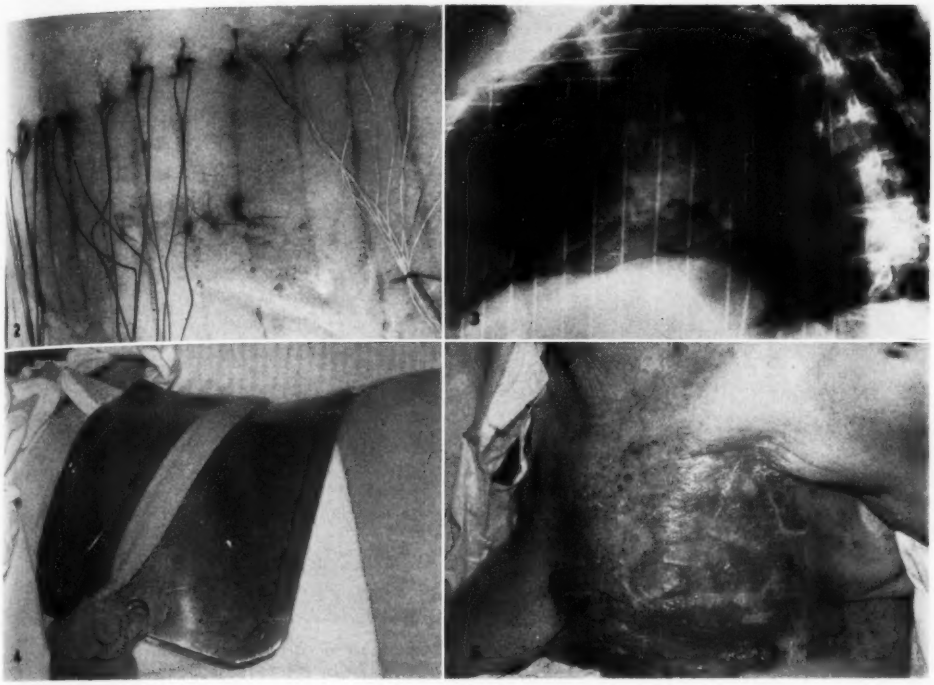
CASE REPORTS

Three implants will be described to demonstrate some special features of this technic: an extensive chest-wall implant (single-plane), a floor-of-the-mouth (double plane) implant, and a pelvic-wall (volume) implant.

CASE I. *Chest-Wall Implant:* Mrs. K., a 72-year-old female, had in July 1958 undergone a left radical mastectomy for a carcinoma of the breast, with postoperative x-irradiation to the left axilla, supraclavicular area, and internal mammary chain. Biopsy in August 1960 revealed two areas of cutaneous adenocarcinoma in the previously unirradiated chest wall. Recommended therapy was interstitial irradiation over an extensive area of the left chest. Accordingly, an area of 285 sq. cm. was implanted with 20 needles of 10 and 12 cm. length and several shorter ones (needle separation, 1.25 cm.). After the needles were sutured in place, the patient was kept in the recovery room for about one hour. She was then sent to the diagnostic x-ray section for localizing radiographs. Following inspection of the radiographs, two needles were repositioned to improve the geometry of the implant. When the patient was fully recovered from the anesthetic and the need for constant nursing care was over, the iridium (Ir^{192}) wires were loaded into the needles. Figures 2 and 3 show the implanted area and the localizing radiograph. Insertion of the wires was easily accomplished; a total of 136 mg. of radium equivalent of iridium was used. Radiation exposure to the left upper chest area of the therapist, who loaded *all* of the needles, was 54 mr, *i.e.*, 0.4 mr/mg. inserted. Allowing for the same area of implantation, a radium-needle implant would have resulted in a minimum exposure of 135 to 175 mr to an experienced therapist (>1 mr/mg. inserted).

The patient received 5,250 rads in ninety-seven hours. A uniform and acceptable reaction developed as illustrated in Figure 5.

An advantage of iridium (Ir^{192}) for afterloading of these needles is the lower gamma energy, *i.e.*, 0.4 Mev instead of 1.2 Mev of cobalt 60 and 1.1 Mev of tantalum (Ta^{182}). This makes the use of protective lead shields a feasible clinical practice. The one used on this patient is shown in Figure 4. Prior to implantation a 1/4-in. lead shield was prepared to fit the chest wall. As soon as the needles were loaded with the radiation sources, the shield was tied in place. It reduced the radiation exposure by a factor of 5.5. Clearly, such a reduction is desirable. Similar



Figs. 2–5. Case I.

Fig. 2. Long hollow stainless steel needles sutured in place at completion of the needle insertion.

Fig. 3. Localizing roentgenogram of the nonradioactive needles.

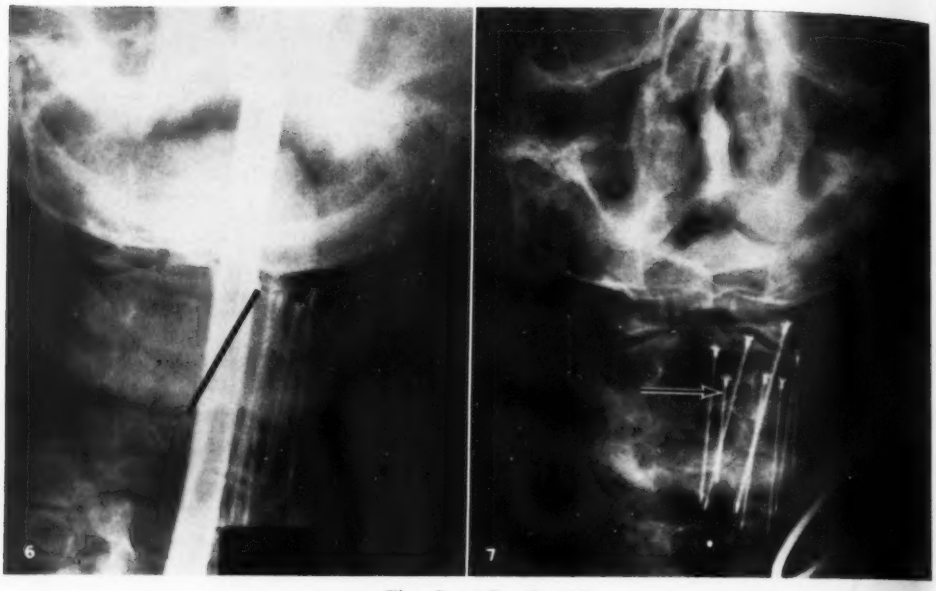
Fig. 4. Lead shield in place following the insertion of the iridium (Ir^{192}) wires. This shield reduces the radiation-exposure above the implant by a factor of 5.5.

Fig. 5. Cutaneous reaction two weeks following the administration of 5,250 rads in ninety-seven hours by an Ir^{192} implant.

shields have been used in 4 other cases, but they are bulky and inconvenient. Now under development is a lead and lead-glass shield which can be attached to the bed so that it will fit over the implanted area without touching the patient.

In this case, three points can be emphasized: (*a*) No radiation sources were handled in the operating room, recovery room, or diagnostic x-ray section. The needles were loaded only after satisfactory localization films were taken and the patient recovered fully from the anesthesia. (*b*) A lead shield made for the patient was a practical means of reducing radiation exposure level around the patient by a factor of 5.5. (*c*) The long, thin needles (10 and 12 cm. length instead of a maximum of 4.5 cm. and 0.9 mm. outside diameter instead of 2.2 mm. for radium needles) were easily and quickly inserted into the thin tissues of the chest wall.

CASE II. *Floor of Mouth:* Mr. W., a 74-year-old male, had an infiltrating squamous-cell carcinoma of the left side of the floor of the mouth, firmly attached to the inner surface of the left mandible. The plan of treatment was to irradiate radically the diseased area, with emphasis on control of the medial extension of the lesion, and to follow by a Commando resection six weeks after completion of radiation therapy. Accordingly, treatment with cesium (Cs^{137}) was given, to a single field, 30 cm. S.S.D., for a dose of 5,000 rads in twenty-three days, immediately followed by a curved double-plane implant with the hollow steel needles. At completion of the implant, radiographs taken in the operating room showed that an anterior 3-cm. needle was badly positioned. It was therefore removed and repositioned, as shown in Figures 6 and 7. At this point—after all the needles were sutured in an acceptable position, the threads were fixed on the outside, and a nasogastric tube was in place—the iridium wires were brought into the operating room and placed in the needles. Nine needles were loaded with iridium equivalent to a total of 18.1 mg. radium. Radiation exposure to the therapist was



Figs. 6 and 7. Case II.

Fig. 6. Roentgenogram showing needle to be poorly positioned. It was withdrawn and reinserted without radiation exposure.

Fig. 7. Postero-anterior localizing radiograph after the malpositioned needle shown in Figure 6 had been reinserted. There is now a satisfactory needle distribution. The arrow points to the repositioned needle.

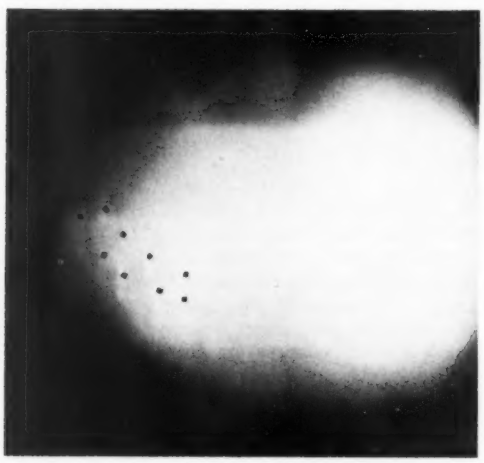


Fig. 8. Case II. Transverse tomogram of the floor-of-mouth implant with hollow stainless steel needle. The needle position is marked with thin tape.

18 mr or 1 mr/mg. equivalent of radium. For a comparable radium needle implant the exposure would have been 25–50 mr (for an experienced therapist) with no repositioning of needles. Figure 8 shows the source distribution. The planes were removed at different times. The final dose 0.5 cm. medial to the inner plane was 7,000 rads/twenty-seven days (cesium 137 and iridium 192 total doses).

CASE III. *Pelvic Wall Implant*[3]: Mrs. E. A., a 74-year-old female, had a large carcinoma of the cervical stump extending down the left lateral vaginal wall well into its lower third. The upper half of the rectovaginal septum was also grossly involved. Disease extended massively through the left paracolpal-paracervical area to the left pelvic wall, to which it was rigidly fixed. The classification was Stage III-B (extension into lower third of vagina and to the pelvic wall).

The treatment was as follows.

June 29–Aug. 9, 1960:

6,000 rads in six weeks total pelvis irradiation; 22 Mev, 4-field technic

Planned supplement: Cervical and vaginal source in addition to left pelvic wall implant.

Aug. 19:

25 mg. radium tube for seventy-two hours in cervical stump

Aug. 26:

15 + 10 + 10 + 0 mg. radium in vaginal applicator for seventy-two hours; 45.5 mg. radium equivalent of Ir^{192} wires in left paracolpal area (9-cm. wires in 12-cm. length needles).

[3] The implantation of the pelvic wall was performed by Dr. Paul Chau of the Radiotherapy Department of the University of Texas M. D. Anderson Hospital and Tumor Institute, Houston, Texas.

Figs. 9 and 10. Case III.

Fig. 9. Pelvic wall implant by a transperineal technic with needles 12 cm. long. The length of the needle covered by tape indicates the length of the iridium wire (Ir^{192}) that was loaded into the needle. The piece of thick tape indicates the position of the single source tandem (25 mg.) inserted one week previously.

Fig. 10. Lateral view of pelvic wall implant.

Volume dose from iridium to volume implanted, 4,300 rads/60 hours (Figs. 9 and 10).

Total dose:

6,000 rads/six weeks, external beam

1,000 rads from the cervical and vaginal radium (4,320 mg. hours)

4,300 rads from iridium wire (Ir^{192}) implant

Total, 11,300 rads/60 days to left pelvic disease.

The afterloading technic was useful here in that a new type of implant was designed to supplement the radiation dose to known residual tumor. The 12-cm. needles were inserted into the remaining tumor transperineally; a finger in the rectum and one in the vagina helped in the positioning of the needles. After the implant was completed and just prior to putting in the vaginal cylinder, 9-cm. lengths of wire were inserted into each needle. A 3-cm. length of plain steel wire was then loaded into the terminal 3 cm. of each needle. Thus, only that part of the needle which was thought to be transfixing tumor contained a radiation source.

Implants of this type have been performed in 5 cases. They have been helpful in supplementing dose levels to residual tumor masses, but experience has been too limited to permit a valid impression of their clinical effectiveness.

DISCUSSION

Afterloading of radiation source holders or devices for interstitial radiation therapy is simple in concept. It was described as early as 1910 by Abbe (Henschke, 1960). During the past decade there has been a renewal of interest in this technic, primarily as a means of reducing radiation exposure to medical personnel. Mowatt and Stevens presented a method which employs stainless steel needles (outside diameter, 2.4 mm.) afterloaded with radon-containing gold capillary tubing. The needles are closed with a screw-fitting cap. There are no eyelets or provision for suturing the needles into the tissues; instead, the needles are fitted into Perspex stabilizers. A method for inserting Teflon tubing into

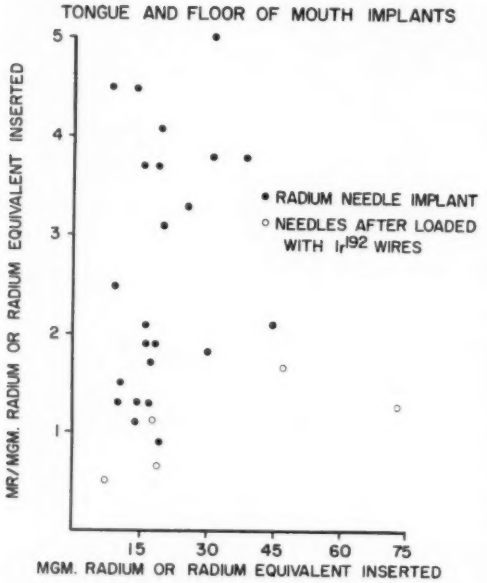

TONGUE AND FLOOR OF MOUTH IMPLANTS
MR/MGM. RADIUM OR RADIUM EQUIVALENT INSERTED
MGM. RADIUM OR RADIUM EQUIVALENT INSERTED
• RADIUM NEEDLE IMPLANT
○ NEEDLES AFTER LOADED WITH Ir192 WIRES

Fig. 11. Radiation exposure levels during tongue and floor-of-mouth implantations as measured by pocket ionization chambers worn over left chest area.

the tissues and loading it with radium needles has been developed by Morphis. This type of implant is restricted to sites suitable for penetration through the treated volume: that is, both ends of the tubing are fixed to the tissues. Henschke, James, and Myers have used Au^{198} seeds (and subsequently Ir^{192}) in nylon tubing for afterloading without rigid source holders; the active ends of the tubing are drawn into the tissue to be treated after the non-active portions have been positioned.

The method described here calls for rigid source holders (to facilitate distribution of needles in near idealized geometric patterns) which may be employed at all sites at present treated by radium needles and in other areas by extension of the basic radium-needle technic. This system has been employed in 29 cases and found to be practical and to possess certain advantages over standard radium needle implantation. Due to elimination of radiation exposure during the needling, there has been a definite improvement of implant geometry. Also, the absence of radiation sources during the implantation encourages and permits more detailed teaching of technic. The radiation exposure is reduced, as shown in Figures 11 and 12. The data were taken from cases of staff radiotherapists or Board-

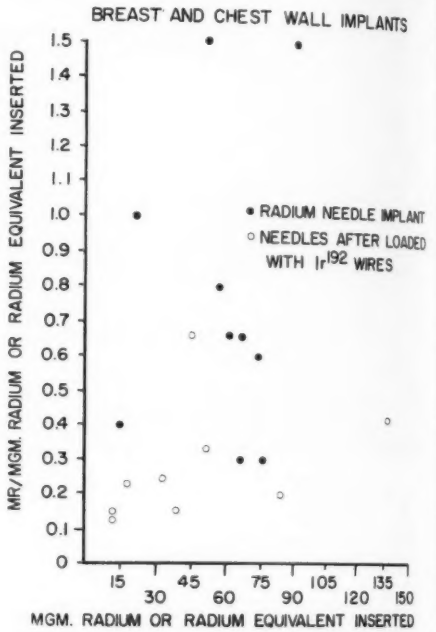

BREAST AND CHEST WALL IMPLANTS
MR/MGM. RADIUM OR RADIUM EQUIVALENT INSERTED
MGM. RADIUM OR RADIUM EQUIVALENT INSERTED
• RADIUM NEEDLE IMPLANT
○ NEEDLES AFTER LOADED WITH Ir192 WIRES

Fig. 12. Radiation exposure levels during breast and chest-wall implantations as measured by pocket ionization chambers worn over left chest area.

qualified Fellows. In neither the intraoral nor the chest-wall implants were there any instances of high-exposure levels in the afterloading implants. With small implants, the radiation exposure (mr/mg. radium or radium equivalent inserted) in radium needle and afterloading cases tended toward the same values for an experienced interstitial therapist. Differences between the two technics were more marked as the total quantity of the radiation source increased. This is evident for two extensive implants performed with the afterloading needles: a 74-mg. intraoral implant and a 136-mg. chest-wall implant. The needles which are much thinner than radium needles (0.9 mm. instead of 2.2 mm. outside diameter) are more easily handled and inserted into the tissues. As a result of increased flexi-

bility of needle use (lengths to 12 cm., all or part, loaded with radioactive wire), two implants of new design have been used. Case III illustrates an implantation of a residual pelvic wall tumor following external beam irradiation. Another new implant is a truncated cone distribution of radiation sources in the retrobulbar region.

The most suitable radioisotope for afterloading needles may not be iridium. Iridium (Ir^{192}) has these advantages: (*a*) a mean effective gamma energy of 0.4 Mev, permitting easy and effective shielding, (*b*) low-energy beta particles so that stainless steel sheaths are satisfactory, (*c*) availability in thin filaments (0.005 in.) allowing the use of needles of small outside diameter, (*d*) low cost of ≈$0.06/cm. length, which makes it practical to dispose of the entire needle and wire immediately upon its removal from the patient.

These advantages are in part offset by the intermediate half-life of 74.5 days. This is so short that fresh sets of iridium wires would have to be ordered, received, calibrated, and stocked every four to eight weeks. Such a high turnover of radiation sources would involve a fairly elaborate bookkeeping system and, without special facilities, an appreciable radiation exposure would be received by personnel in calibrations. Before iridium is decided upon, the possibility of longer-lived isotopes, such as cesium 137, will be explored. Cobalt (Co^{60}) is considered unsatisfactory because of the high gamma energy and the intermediate half-life. It is believed, however, that the technic of afterloading radiation sources into rigid needles has been proved practical and will be adopted in this institution as a standard method.

SUMMARY

A technic has been described for afterloading radiation sources (Ir^{192} wire) into thin stainless steel needles. This method has several advantages over radium needle implants: improved implant geometry, reduction of radiation exposure level, increased flexibility of implant design, greater ease of needle insertion, and reduced tissue trauma. Case reports of three different implant types are presented.

6723 Bertner St.
Houston 25, Texas

REFERENCES

HENSCHKE, U. K., JAMES, A. G., AND MYERS, W. G.: Radiogold Seeds for Cancer Therapy. Nucleonics **11**: 46–48, May 1953.

HENSCHKE, U. K.: "Afterloading" Applicator for Radiation Therapy of Carcinoma of the Uterus. Radiology **74**: 834, May 1960.

MORPHIS, O. L.: Teflon Tube Method of Radium Implantation. Am. J. Roentgenol. **83**: 455–461, March 1960.

MOWATT, K. S., AND STEVENS, K. A.: Afterloading—a Contribution to the Protection Problem. J. Fac. Radiologists **8**: 28–31, July 1956.

PRICE, B. T., HORTON, C. C., AND SPINNEY, K. T.: Radiation Shielding. London, Pergamon Press, 1957.

STROMINGER, D., HOLLANDER, J. M., AND SEABORG, G. T.: Rev. Mod. Physics **30**: 767, 1958.

WILSON, C. W.: Radium Therapy: Its Physical Aspects and Extensions with Radioactive Isotopes. London, Baillière, Tindall & Cox, 1956.

SUMMARIO IN INTERLINGUA

Un Technica de Cargation Ulterior con Agulias Rigide in le Therapia Radiational Interstitial

Es describite un technica pro le cargation ulterior del fonte de radiation (filos de Ir^{192}) in fin agulias de aciero inoxydabile. Iste methodo esseva usate in 29 casos. Illo offere plure avantages in comparation con le uso de agulias de radium. Tal avantages es le meliorate geometria del implantas, un reducite nivello del exposition a radiationes, un plus grande flexibilitate del conformation del implantas, le plus facile insertion del agulias, e un reducite traumatisation tissular. Es presentate reportos de casos que illustra implantationes de tres differente typos, i.e. un implantation extense in le pariete thoracic (a plano unic), un implantation in le fundo buccal (a plano duple), e un implantation in le pariete pelvic (a volumine).

Technical Considerations in Scintillation Scanning of the Human Spleen[1]

PHILIP M. JOHNSON, M.D.[2], and JOHN C. HERION, M.D.

THE PURPOSE OF this communication is to present in detail two methods used at the School of Medicine of the University of North Carolina during the past year for area scintillation scanning of the human spleen. The feasibility of one of these methods has been outlined in a preliminary report (1); the result of investigation of the normal and diseased spleen, using both methods, has been presented elsewhere (2). These methods, derived from experimental technics of Jandl *et al.* (3) and Harris *et al.* (4) for studying red cell destruction, are in essence means of modifying red blood cells so as to promote their rapid selective sequestration from the circulation, primarily within the functioning spleen.

METHOD

1. Preparation of Red Cells: In preparation for scintillation scanning, red cells may be altered in two ways. In the D-positive subject, isologous red cells may be "sensitized" *in vitro* by coating with incomplete anti-D antibody. In subjects of all blood group genotypes, red cells may be modified by controlled heating to produce changes in morphology and in osmotic and mechanical fragility similar to those seen in the erythrocytes of patients with hereditary spherocytosis.

(*a*) *"Sensitized" Red Cells:* From a D-positive subject a quantity of venous blood sufficient to contain 6 ml. of red cells is withdrawn; this is placed in a heparinized tube. Sterile technic is used throughout the entire procedure. The red cells are washed five or six times, or until washings are clear, each with 2 volumes of sterile isotonic saline to remove plasma proteins. The cells are then resuspended in 1 to 2 ml. of sterile isotonic saline. To the red cell suspension is added 0.5 ml. of a 1:128 saline dilution of sterile pyrogen-free human anti-D serum.[3]

The mixture is incubated at 37°C. for fifteen minutes. Thereafter red cell testing with a standard Coombs' serum is performed to insure that full sensitization has occurred. Alternatively, homologous D-positive red cells may be utilized in an identical manner, after compatibility with the recipient is demonstrated by cross-matching. Such cells can be obtained from outdated (one day overage) banked blood.

(*b*) *Heated Red Cells:* Isologous or compatible homologous red cells are prepared as follows: A quantity of venous blood containing 6.0 to 8.0 ml. of red cells is obtained as described above. The whole blood is placed in a sterile rubber-sealed bottle and heated in a water bath at 49.6 to 49.8°C. for fifteen minutes. It is then cooled immediately in a second water bath at room temperature for fifteen minutes.

(*c*) *Chromium-51 Labeling of Red Cells:* One hundred to two hundred microcuries of hexavalent sterile chromium 51, as sodium chromate,[4] are added to the suspension of the *sensitized* red cells, which is then periodically agitated gently for one hour while remaining at room temperature. The labeling process is then terminated by the addition of 100 mg. of ascorbic acid.

Labeling of *heated* cells is initiated immediately before heating and terminated thirty minutes later by addition of 100 mg. of ascorbic acid. The labeled cells

[1] From the Departments of Radiology and Medicine, The School of Medicine, The University of North Carolina, Chapel Hill, N. C. This investigation was supported by U. S. Public Health Service Grant A-1996(C1). Accepted for publication in August 1960.

[2] Present address: 141 Central Avenue, Montclair, N. J.

[3] The human anti-D serum used in this investigation was obtained from the Philadelphia Serum Exchange in original titer 1:512 (Lot No. 448) and was stored at −10°C.

[4] Obtained as Chromitope Sodium from E. R. Squibb & Sons, New Brunswick, N. J.

are then administered to the recipient by slow intravenous injection.

2. Survival of Transfused Red Cells: Prior to injection of radioactive red cells, a control sample of venous blood is withdrawn from the recipient. Following injection, serial blood samples are obtained from the opposite arm at two, ten, twenty, forty, sixty, one-hundred twenty and two-hundred forty minutes and at twenty-four hours. Each sample is placed in a bottle containing dried 10 per cent aqueous sodium Sequestrine, 0.5 ml., and is prepared for radioactivity counting as follows: After 50 inversions of the capped bottle, 2.0 ml. of whole blood are transferred to a counting bottle with a volumetric pipette. The remaining blood is centrifuged to separate the cells and plasma. Exactly 2.0 ml. of supernatant plasma are transferred to a counting bottle. To avoid correction for physical decay of chromium 51, all whole blood and plasma samples from a given subject are prepared and counted in sequence in a well counter, sufficient counts being obtained to insure a counting error of less than 3 per cent. The red cell radioactivity is taken as the whole blood radioactivity minus plasma radioactivity, calculated from the hematocrit value obtained for each whole blood sample, and is expressed in counts per minute per milliliter. The values of red cell radioactivity are plotted on semilogarithmic paper and the instantaneous value (at time zero) is found by extrapolation, thus permitting expression of red cell radioactivity at any time as a percentage of its instantaneous value.

3. In Vivo Radioactivity Recording Technics (Fig. 1). (a) "Spleen-Liver Ratio": To measure the appearance and rate of accumulation of radioactive red cells in the spleen and liver, two identical scintillation probe-linear ratemeter systems are employed. The 1-inch scintillation crystals are lead-shielded; wide-angle collimators are attached. Each system contains a differential spectrometer with "window" of 100 kev height based on 274 kev in order to accept only those pulses whose energy is 324 kev (gamma photopeak of chromium 51) ±50 kev. The two systems are calibrated to insure identical response to a given radiation source under constant geometrical conditions.

In the presence of functioning splenic tissue, 324 kev radioactivity becomes detectable in the spleen and liver within a few minutes after injection of red cells. Each scintillation probe is moved over the posterior surface of the recipient's abdomen until the loci of maximum radioactivity emerging from the spleen and liver are found. These skin points are then marked indelibly and, with each probe in contact with the skin and centered over one skin point, the number of counts per minute is measured simultaneously at each locus. Immediately each probe is then placed in contact with the posterior surface of the ipsilateral thigh and the number of counts per minute recorded. These values, considered to represent "room background" plus "body background" radioactivity, when subtracted from the count rates obtained at the external loci of splenic and hepatic radioactivity, give net values for the latter. The spleen:liver ratio (S:L ratio) is calculated:

$$\frac{\text{net external splenic radioactivity in counts per minute}}{\text{net external hepatic radioactivity in counts per minute.}}$$

Serial determinations of this ratio are made, usually at the time of blood sample withdrawal. The twin scintillation probes are locked in true vertical position for all body-surface counting measurements. A ten-second time constant is set into each ratemeter to minimize fluctuations and assure greater statistical accuracy of readings. The position of the subject is reproduced at each reading. Those with small or normal-sized spleens are studied in the prone position; the supine position is used when splenomegaly is present, in which case the loci of maximum splenic and hepatic radioactivity are found on the anterior abdomen.

(b) Scintillation Scanning: In the majority of cases studied, sufficient radioactivity to permit scanning has accumu-

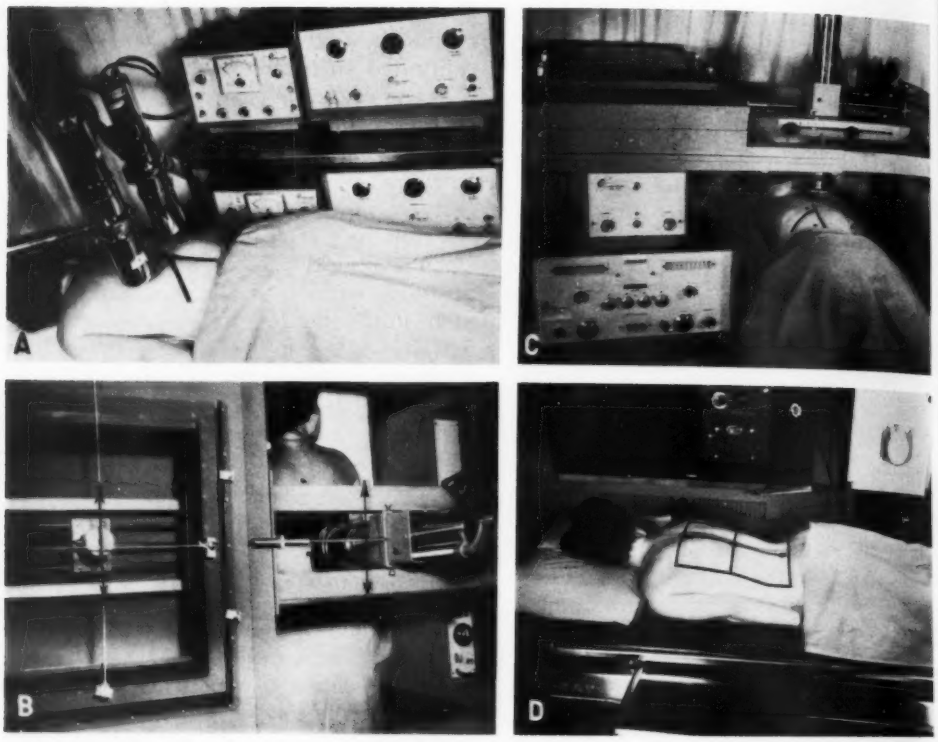


Fig. 1. Scanning technic. A. Step 1: Measurement of spleen:liver ratio. B. Step 2: Alignment of patient to center of photoscanner. C. Step 3: Photoscan in progress; simultaneous "dot" scan serves as control. D. Step 4: Superimposition of radiographic and photoscan fields.

lated within one or two hours after injection. Since the level of circulating radioactivity is relatively high at this time, the scanning procedure is preferably done between the fourth and twenty-fourth hour after injection. Use is made of a commercially available scanning apparatus with lead-shielded 2-inch crystal, differential spectrometer ("window" setting as in the determination of the spleen-liver ratio), and simultaneous stylus and light-beam printing systems. Two modifications of collimation have facilitated splenic scanning: the lead collimator or nosepiece of the scanning probe contains a single axial cylindrical aperture of 5/8-in. diameter, and the light beam by which the photoscan is printed is made to pass through a rectangular aperture 3.5 × 7.0 mm. A contrast enhancement circuit is used whenever splenic radioactivity is sufficiently great. Prior to scanning, the location of pertinent body surface landmarks is printed to provide reference points. These landmarks are the posterior body midline and lowest palpable left rib in posterior scans (subject prone); the xiphoid, umbilicus, and left costal margin for anterior scans (subject supine). During the scan the scintillation probe is kept as close as possible to the skin.

Superimposition of the roentgenographic image of the spleen upon its photoscan image is accomplished by exposing the latent undeveloped photoscan to an x-ray beam. Care must be taken to insure that the subject's position is identical during scanning and roentgenography, and that the central beam passes through the center of the field of scan. During roentgen exposure the subject is instructed to maintain apnea, with the diaphragm approximately midway between the inspiratory and expiratory limits of shallow breathing.

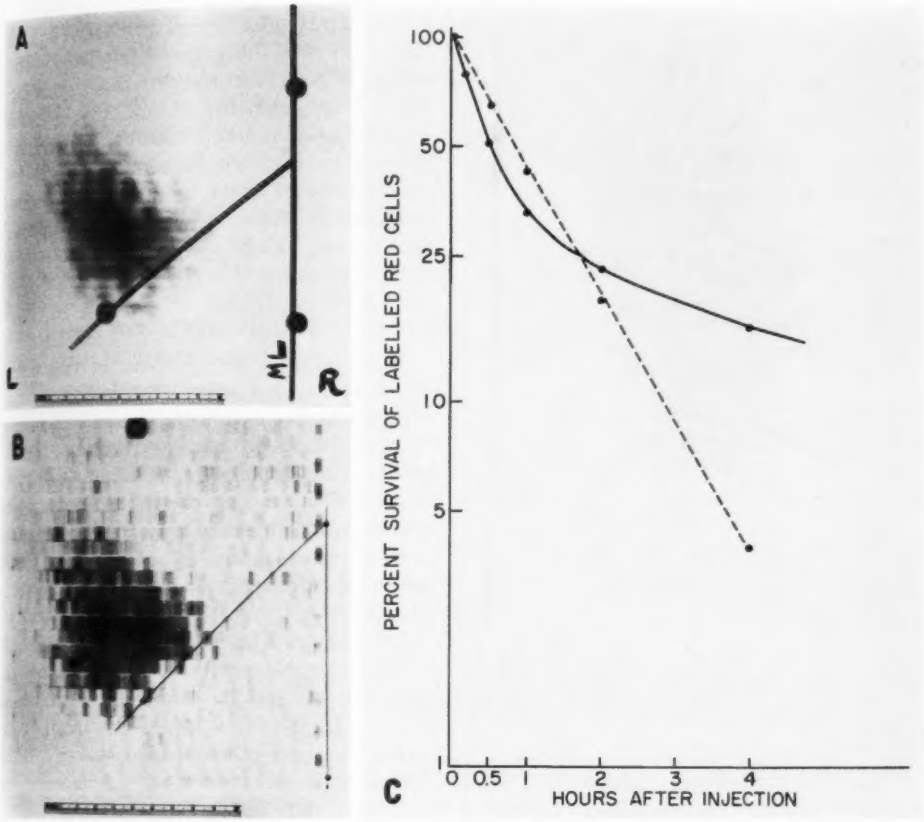


Fig. 2. Results of investigations in a 36-year-old D-positive male with normal spleen. A. Posterior photoscan of spleen following uptake of homologous sensitized red cells. B. Repeat posterior photoscan of spleen six months later. Isologous heated red cells were utilized. C. *In vivo* survival of the radioactive red cells used to obtain these splenic scans. Broken line: Homologous sensitized cells. Solid line: Isologous heated cells. The clearance curve of the heated cells can be resolved into "fast" and "slow" exponential components.

RESULTS

To date 30 subjects have been investigated with these technics. In no case has an untoward clinical or hematological reaction been observed following administration of isologous or homologous heated or sensitized radioactive red cells.

Among 12 patients hospitalized for chronic pulmonary disease and without clinical or laboratory evidence of splenic or hematologic disease, there was only 1 failure to exhibit selective splenic sequestration of sensitized or heated cells. This failure is unexplained but, in view of the rapid hepatic concentration of sensitized red cells, it is possible that intravascular agglutination of coated cells occurred, as suggested in a patient studied by Jandl *et al.* (3). This patient's illnesses were pulmonary tuberculosis and a verified cerebral metastatic adenocarcinoma, primary site undetermined.

In the above group of "normal" subjects, with the exception noted, satisfactory splenic scans were obtained (Fig. 2). By the fourth hour after injection the average spleen-liver ratio was approximately 5.0:1. The average half-survival time in the circulation of sensitized cells is forty-six minutes (9 cases) and of heated cells, twenty minutes (4 cases; 1 subject in this series had been studied six months earlier with sensitized cells). Both single and double-component exponential red

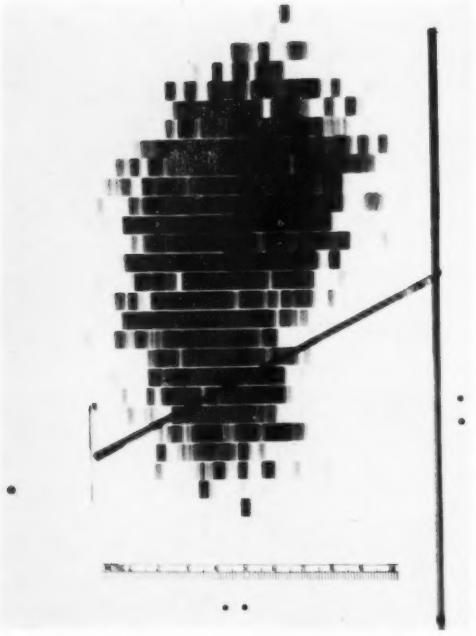


Fig. 3. Posterior photoscan demonstrating marked splenomegaly in a patient with Laennec's cirrhosis. Isologous heated red cells were employed in this instance. As in Figure 2, the patient's left side is to the reader's left.

cell survival curves were observed. Peak external splenic radioactivity appeared between four and twenty-four hours after injection; thereafter both splenic and hepatic radioactivity decreased slowly due to two exponential processes: physical decay and release of chromium from its parenchymal sequestration sites. The half-lives of the latter process are in the order of forty days (spleen) and one-hundred two days (liver).

Among 18 subjects with abnormalities of the spleen, including splenomegaly and splenic atrophy from various causes, there was failure to obtain a satisfactory splenic scan in 3. In 1 of these the failure is attributable to intentionally insufficient heating of red cells. The next failure occurred in a 30-year-old Negro male with proved sickle-cell anemia and a non-palpable spleen. In this patient the slow clearance of heated red cells from the circulation and inversion of the spleen:liver ratio (0.5:1 at twenty-four and at forty-eight hours) are suggestive of virtual absence of splenic function, or "autosplenectomy" (5). The last failure occurred in a 32-year-old white female with chronic myelogenous leukemia and marked hepatosplenomegaly; in this subject the spleen:liver ratio remained near unity. In the remaining subjects in this group satisfactory splenic scans were made after administration of sensitized and of heated red cells (Fig. 3).

DISCUSSION

It is beyond the purpose of this communication to discuss what is known and unknown about the mechanisms of intrasplenic trapping and destruction of red cells. The technics described in this paper empirically exploit these mechanisms to produce a concentration of gamma radioactivity in the spleen in a manner analogous to the trapping of iodide in the thyroid gland.

Of the two methods, the heated cell technic seems preferable because of its simplicity and independence of Rh genotype. In blood samples so treated no evidence of gross hemolysis has been found, although it is favored by the increase in osmotic and mechanical fragility. The sensitized cell method requires more time and some knowledge of serological procedures; it is more tedious and can be safely used only in D-positive subjects. The red cells must be washed after sensitization to remove excess (unbound) anti-D serum to prevent intravascular cell coating.

Two additional technics merit investigation. First, a source of coated red cells exists in patients with auto-immune hemolytic anemias. Such cells would undergo sequestration in a recipient's spleen and liver (6) and would require only prior labeling with chromium 51. Second, the use of iodine 131 as a label to anti-D antibody would obviate the need for labeling red cells after coating, and would also reduce the total radiation dose to the recipient.

The utilization of a 3-inch scintillation crystal for splenic scanning should permit

great increase in resolution. Therefore it was disappointing to find that the sensitivity of such a crystal, when used with a 61-hole honeycomb collimator, was insufficient to produce satisfactory scans in the dosage range of chromium 51 used in this investigation. However, it would appear that high resolution, although desirable, is not as necessary in splenic scanning as in thryoidal scanning; in the former, one is not usually seeking out small lesions or slight variations in concentration of radioactivity.

SUMMARY

Two methods of preparing isologous or compatible homologous red cells for splenic scintillation scanning are described. Application of these methods in 30 subjects, including 18 with splenic abnormalities, has resulted in satisfactory splenic area scans in all but 4 after rapid deposition of prepared radioactive red cells primarily in the spleen.

ADDENDUM

Since completion of this communication, Winkelman *et al.* (7) have reported successful splenic scintillation scanning in 17 subjects using a "heated cell" technic also based upon the work of Harris *et al.* (4). Their results appear comparable to those described above; however, their method imposes an additional forty-five minutes on the red cell preparation time.

141 Central Ave.
Montclair, N. J.

REFERENCES

1. JOHNSON, P. M., HERION, J. C., AND MOORING, S. L.: Scintillation Scanning of the Normal Human Spleen Utilizing Sensitized Radioactive Erythrocytes. Radiology **74:** 99–101, January 1960.

2. JOHNSON, P. M., WOOD, E. H., AND MOORING, S. L.: Splenic Scintillation Scanning. Presented at the Sixty-first Annual Meeting, American Roentgen Ray Society, Atlantic City, N. J., Sept. 27–30, 1960.

3. JANDL, J. H., JONES, A. R., AND CASTLE, W. B.: The Destruction of Red Cells by Antibodies in Man. I. Observations of the Sequestration and Lysis of Red Cells Altered by Immune Mechanisms. J. Clin. Invest. **36:** 1428–1459, October 1957.

4. HARRIS, I. M., MCALISTER, J. M., AND PRANKERD, T. A.: The Relationship of Abnormal Red Cells to the Normal Spleen. Clin. Sc. **16:** 223–230, May 1957.

5. JANDL, J. H., GREENBERG, M. S., YONEMOTO, R. H., AND CASTLE, W. B.: Clinical Determination of the Sites of Red Cell Sequestration in Hemolytic Anemias. J. Clin. Invest. **35:** 842–867, August 1956.

6. SCHLOESSER, L. L., KORST, D. R., CLATANOFF, D. V., AND SCHILLING, R. F.: Radioactivity Over the Spleen and Liver Following the Transfusion of Chromium51-Labelled Erythrocytes in Hemolytic Anemia. J. Clin. Invest. **36:** 1470–1485, October 1957.

7. WINKELMAN, J. W., WAGNER, H. N., JR., MCAFEE, J. G., AND MOZLEY, J. M.: Visualization of the Spleen in Man by Radioisotope Scanning. Radiology **75:** 465–466, September 1960.

SUMMARIO IN INTERLINGUA

Consideratione Technic Relative al Scrutinio Scintillational del Splen in Humanos

Es describite duo methodos pro le preparation de erythrocytos isologe o compatibilemente homologe pro objectivos de scrutinios scintillational del splen. Le application de iste methodos in 30 subjectos—incluse 18 con anormalitates splenic—resultava in satisfacente scrutinios de area splenic in omnes excepte 5, post le deposition rapide de preparate erythrocytos primarimente ad in le splen. Reactiones adverse clinic o hematologic non esseva observate in ulle del casos post le administration de isologe o homologe erythrocytos calc facite o sensibilisate.

Congenital Generalized Fibromatosis

Case Report, with Roentgen Manifestations[1]

VIRGIL R. CONDON, M.D., and R. PARKER ALLEN, M.D.

SINCE THE original description of congenital generalized fibromatosis by Stout (5) in 1954, only 2 cases of this rare condition could be found in the literature. The disease consists of a heterogeneous group of hyperplastic and dysplastic lesions of connective tissue, occupying a poorly defined position between proliferation and repair *vs.* unequivocal neoplasia (4). In none of the 3 previous case reports was there any significant discussion of the bony manifestations. It is the purpose of this paper to record another example and describe the roentgen manifestations in relation to the skeletal system.

CASE REPORT

A white male infant was admitted to the Denver Children's Hospital at the age of three months, chiefly because of difficulty of breathing, loose, bloody bowel movements, and failure to gain weight.

The illness had its onset at the age of one month with diarrhea and the appearance of subcutaneous nodules. The child was hospitalized at that time and roentgen examination showed a pulmonary infiltration, inflammatory in appearance, and multiple lytic bone lesions. At this first admission a biopsy of a subcutaneous lesion was interpreted as showing neurofibromatosis but on subsequent biopsy this diagnosis was changed to congenital generalized fibromatosis.

After discharge, the child failed to thrive and he was readmitted to The Children's Hospital. Additional study revealed an uneventful prenatal history and labor. The mother and father were well. Siblings included a brother of seven, a sister aged two, both healthy, and an infant who had died thirty-six hours after birth, reportedly because of a "collapsed lung."

Physical examination showed a malnourished, poorly developed infant in moderate respiratory distress. The temperature was 99.4° F., the pulse 152, and respirations 28. The height was 54.9 cm.; the weight, 8 lb.; the head circumference, 36.7 cm. Auscultation of the chest demonstrated decreased breath sounds and a tachycardia with P2 greater than A2. There were no murmurs. The liver was palpable 1.5 cm. below the right costal margin. Multiple soft subcutaneous boggy tumors were observed in all the extremities, the thorax, and buttocks.

Laboratory examination revealed a hemoglobin of 9.4 gm. per 100 c.c. and a leukocyte count of 10,000. Urinalysis was negative. Throat cultures showed growth of *Staphylococcus aureus*. Stool cultures showed *Endamoeba coli* and were 1+ for occult blood. Additional laboratory findings were as follows: serum calcium, 9.8 mg. per 100 c.c., ionized protein, 5.2 mg. per 100 c.c., inorganic phosphorus 5.2 mg. per 100 c.c., alkaline phosphatase, 8.6 mg. per 100 c.c., total serum protein, 5.1 gm. per 100 c.c., with an albumin-globulin ratio of 0.7. Electrophoresis revealed a slight accentuation of the alpha-2 fraction and a depression of the alpha-1 globulins.

The patient did poorly in the hospital and died after ten days. Bronchopneumonia was the immediate cause of death.

Autopsy: At autopsy the pertinent findings consisted of multiple nodules of variable size in the skeletal system, lungs, heart, liver, muscle, and small and large intestine. Grossly the nodules were firm but slightly rubbery, gray in color, and up to 1 cm. in diameter. Microscopically, they were composed of loosely arranged interlacing bundles of elongated, spindle-shaped cells with a pale, pink-staining, homogeneous matrix and elongated nuclei. Some cells had a finely granular chromatin pattern. The final pathologic diagnosis was congenital generalized fibromatosis.

CLINICAL ASPECTS AND NATURE OF THE DISORDER

This rare disorder of fibroelastic derivation is manifested by widespread, multiple, locally infiltrating lesions, which may involve any organ or system. Their inception is thought to be *in utero*, and they continue to enlarge during life. Microscopically they show fibroelastic tissue without mitotic figures. Anaplasia and cellular atypism are generally lacking (4). Each nodule is believed to be primary and not metastatic (5). Their appearance at times has been that of differentiated fibrosarcoma (6).

Congenital generalized fibromatosis has been reported in both sexes. Prior to the present report, the longest survival was

[1] From the Children's Hospital, Denver, Colo. Accepted for publication in September 1960.

Fig. 1. Film of the lower extremities showing marked involvement of the metaphyseal and diaphyseal portions of all the long bones.
Fig. 2. Single film of the arms demonstrating similar but less extensive involvement of the humerus, radius, and ulna.
Fig. 3. Intravenous urogram showing cystic lesions in the scapula, ribs, and pelvis.
Fig. 4. Lateral view of the thoracic and lumbar spine showing involvement of these areas, the pelvis, and the femora.

twenty-two days. All cases have been in white children, and none have been familial. The etiology is unknown, although similar lesions have been produced experimentally in adult guinea-pigs by prolonged administration of estrogenic substances (3).

Fig. 5. Enlarged view of the right knee demonstrating to better advantage the more typical appearance of fibromatosis. The metaphyseal areas are almost completely destroyed by the cystic lesions. These are well marginated and there is extensive cortical destruction.

ROENTGEN MANIFESTATIONS

In only 1 of the 3 cases of congenital fibromatosis previously reported were bony changes present, and in that instance they were limited to one hip. In the case reported in this paper, there was multiple involvement of the entire skeletal system: specifically, lesions were located in the ends of the long bones, in the ribs, pelvis, scapula, vertebrae, mandible, and the skull.

The lytic destructive areas in the long bones, produced by these fibromas, appeared to be both medullary and cortical in origin. While some of the bones showed slight expansion, in the cortical lesions there was destruction of the cortex. Pathological fractures of the ribs had occurred. The lytic lesions were lobulated and well marginated but there was little, if any, sclerosis along the margins. Lesions in the flat bones were essentially the same as in the long bones. Compression fractures were seen in several of the vertebrae. An upper gastrointestinal series as well as a barium-enema examination failed to demonstrate the intestinal manifestations of the disease. An intravenous urogram was normal.

Certainly, the bone lesions in this case would indicate a generalized process, but the disease can be present without any definite skeletal involvement, and the osseous manifestations may be extremely variable. Although congenital fibromatosis is rare, it should be considered when nonspecific lytic lesions are seen in the young infant, even though only one or a few defects are demonstrated in a skeletal survey.

DIFFERENTIAL DIAGNOSIS

The primary conditions to be considered in the differential diagnosis of congenital generalized fibromatosis are: reticuloendotheliosis, neurofibromatosis, metastatic neuroblastoma, fibrous dysplasia, internal chondromatosis, lipomatosis, lymphangiomatosis, and intraosseous hemangiomas.

Reticuloendotheliosis is probably the primary differential consideration. Of that group of diseases, the one that produces clinical and roentgen abnormalities in the infant age group is generally classified as Letterer-Siwe's disease. Its lesions have many roentgenologic manifestations similar to those of generalized fibromatosis. Typically, the defects are lytic, with poorly defined borders that at times may evoke some periosteal new bone formation. They are located in the spongiosa, with secondary involvement of the cortex. Pathological fracture of the long bones is not uncommon; the skull is an area of frequent involvement. The characteristic of Letterer-Siwe's disease that helps most in its differentiation is the poor demarcation of the margins of the lesions. While skeletal fibromas do not show sclerotic reactive margins, they are fairly well marginated. In addition, generalized fibromatosis may be manifest in the newborn infant, whereas

reticuloendotheliosis is generally seen in a slightly older age group.

On the basis of the roentgen findings alone, neurofibromatosis is also a somewhat difficult differential consideration. Here multiple cystic, lytic, and medullary defects are demonstrated in an infant. In general, however, the skeletal changes appear in an older age group, and the margins of the lesions almost always show some sclerosis. Another differential feature is the occasional presence of calcium in neurofibromas. Agneessens (1) reported a case showing cystic bone lesions in a seven-week-old female. In this connection it is of interest that on the original biopsy in our case the microscopic diagnosis was neurofibromatosis and it was not until later biopsy and autopsy examination that the diagnosis of generalized fibromatosis was definitely established.

Neuroblastoma must certainly be included in the differential diagnosis. This metastatic bone lesion is not uncommon in the age group with which we are concerned, but the roentgen findings are more typical of malignant disease, tending to be more diffusely "moth-eaten" and rarely showing any expansion or reactive bone.

Fibrous dysplasia in its polyostotic or monostotic form would need to be differentiated from multiple or solitary intramedullary fibroma. In fibrous dysplasia, however, the marrow cavity is frequently dilated, with thinning of the walls and bulging of the margins; the lesion is medullary and more often metaphyseal. Probably the most significant differential finding is the sclerotic margin seen in fibrous dysplasia. It is unusual for the disease to be observed in infancy.

Internal chondromatosis is a relatively rare condition that may produce lytic, irregularly dilated lesions at the ends of long bones. These grossly disturb the growth at the epiphyseal plate, with associated growth deformity.

Lymphangiomatosis and intraosseous hemangiomas also produce lytic defects in the long bones that may present definite differential considerations. Both are exceedingly rare in this age group, however, and they tend to produce a somewhat more cystic appearance. Hemangiomas often stimulate the bones to overgrowth, producing disproportionate size of an extremity.

Fig. 6. Enlarged roentgenogram of the left distal femur showing extensive lytic lesions producing a slight expansion of the cortex without a definite break.

The very rare condition of multiple lipomatosis may occasionally affect bones and produce lesions similar to those of fibromatosis. It is, of course, much more common for this disease to produce extensive soft-tissue lesions. As in neurofibromatosis, the lesions occasionally contain demonstrable calcium.

SUMMARY

What is believed to be the fourth recorded case of congenital generalized fibromatosis is reported. This is a rare disease characterized by hyperplastic and dysplastic connective-tissue lesions that may involve any or all of the organ systems. It has been uniformly fatal in the 4 known

cases, the oldest patient being three months of age at the time of death.

Roentgen examination of the skeleton in the present case showed lytic destructive lesions in the medullary and cortical portions of the long bones as well as in the flat bones. The defects are well marginated, with little sclerosis. Reticuloendotheliosis is the most common condition requiring differentiation.

Children's Hospital
Denver 18, Colo.

REFERENCES

1. AGNEESSENS, A.: Unusual Case of Neurofibromatosis in an Infant. Maandschr. v. kindergeneesk. **18:** 347–353, 1950.
2. NADEL, E. M.: Histopathology of Estrogen-Induced Tumors in Guinea Pigs. J. Nat. Cancer Inst. **10:** 1043–1065, April 1950.
3. REYE, R. D. K.: Consideration of Certain Subdermal "Fibromatous Tumours" of Infancy. J. Path. & Bact. **72:** 149–154, July 1956.
4. SHNITKA, T. K., ASP, D. M., AND HORNER, R. H.: Congenital Generalized Fibromatosis. Cancer **11:** 627–639, May-June 1958.
5. STOUT, A. P.: Juvenile Fibromatoses. Cancer **7:** 953–978, September 1954.
6. WILLIAMS, J. O., AND SCHRUM, D.: Congenital Fibrosarcoma: Report of a Case in Newborn Infant. Arch. Path. **51:** 548–552, May 1951.

SUMMARIO IN INTERLINGUA

Congenite Fibromatosis Generalisate. Reporto de un Caso, con Manifestationes Roentgenologic

Es reportate un caso de congenite fibromatosis generalisate, le quarte—il pare—in le litteratura. Isto es un morbo rar, characterisate per hyperplastic e dysplastic lesiones de tissu conjunctive, le qual pote afficer non importa le qual del systemas o omne le systemas organic. Illo ha essite fatal uniformemente in le 4 cognoscite casos.

Le examine roentgenologic del skeleto in le presente caso revelava lytic lesiones destructive in le portiones medullari e cortical del ossos longe si ben como del ossos platte. Le defectos es nettemente marginate e monstra pauc sclerosis. Reticuloendotheliosis es le condition le plus commun ab le qual congenite fibromatosis generalisate debe esser differentiate.

Lymphangioma of Bone[1]

CHARLES E. SHOPFNER, M.D.,[2] and R. PARKER ALLEN, M.D.[3]

ONLY 3 REPORTS of primary lymphangioma of bone were found in the literature. Since none of these has appeared in radiological journals, a fourth case is presented with a brief review of the findings in the previous 3. The first report concerned a case localized to the ilium; in the other 2 multiple bone sites were involved. In the example to be reported here the bone lesions were widespread. All cases show lytic bone defects which increase in size until structural units give way or until vital organs are involved by pressure or direct extension. Microscopically the lesion consists of dilated lymphoid channels.

HISTORICAL REVIEW

In 1947 the first case of lymphangioma of bone was recorded by Bickel and Broders (1). The patient, a five-year-old girl, showed almost complete destruction of the left ilium. The process progressed, with partial collapse of the pelvis and with extension to the sacrum and hip. A course of x-ray therapy had no effect and extension continued.

Cohen and Craig (2) presented a patient who had numerous destructive lesions of bone with a six-year clinical and x-ray record showing relentless progression in spite of curettage and x-ray therapy. At autopsy lesions consisting of dilated lymphatic spaces were found throughout the skeleton. The spleen showed similar changes and there was a marked pleural effusion thought to be due to pleural involvement. The authors discussed the nature of the lesion in terms of classification and in relation to somewhat similar cases of widespread hemangiomata.

Harris and Prandoni (3) reported a case with multiple bone lesions and congenital lymphedema of the left forearm.

[1] Accepted for publication in September 1960.
[2] St. Mary's Hospital, Grand Junction, Colo.
[3] Children's Hospital, Denver, Colo.

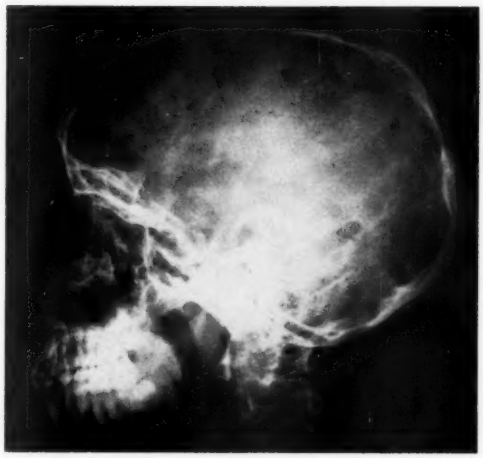


Fig. 1. Multiple lytic defects in the skull. Some of the areas show a small zone of sclerosis, others have a "soap-bubbly" appearance. The external table is slightly thinned in a few areas, but the lymphangioma has not broken through.

In addition to these 3 clear-cut cases of lymphangioma, Parsons and Ebbs (4) described a case with both dilated lymph and blood vessels. It showed extensive visceral involvement and could be a transition type between lymphangioma and hemangioma.

CASE REPORT

R. R. L., a 15-year-old boy, was admitted for investigation of bone defects found incidentally on a chest roentgenogram for pneumonia a week before. There had been a leg fracture at the age of four years, at which time no mention had been made of any unusual x-ray finding. The films were not available. At eight years the right clavicle was fractured and the local doctor told the family that some cysts were present, but further investigation was not carried out. On admission, no history of symptoms referable to the skeletal system could be elicited. Physical examination was entirely negative except for borderline enlargement of the spleen.

Routine blood and urine examinations were negative. Calcium was 8.8 mg. per cent, phosphorus 5.1 mg. per cent, alkaline phosphatase 7.1 Bodansky units.

Roentgenograms of the skeleton showed lytic, cyst-like defects in the skull, ribs, humeri, femora, and tibiae (Figs. 1–5). The lesions varied from a few millimeters to about 3 cm. in diameter and were

sharply defined, with a slightly dense margin. There was no generalized alteration of mineralization and no cortical resorption.

Biopsy of a tibial lesion showed a normal external cortex which, when opened, was thinned to about 1 mm. Under this thin cortex was a fluid-filled space containing some floating "villous bodies." No cyst lining could be identified grossly. Histologically, there was an endothelial-lined space surrounded by plasma cells and lymphocytes in a meshwork of young fibroblasts (Fig. 6). The pathologist's diagnosis was lymphangioma. The patient was discharged without specific therapy, and a follow-up examination has not been obtained to date.

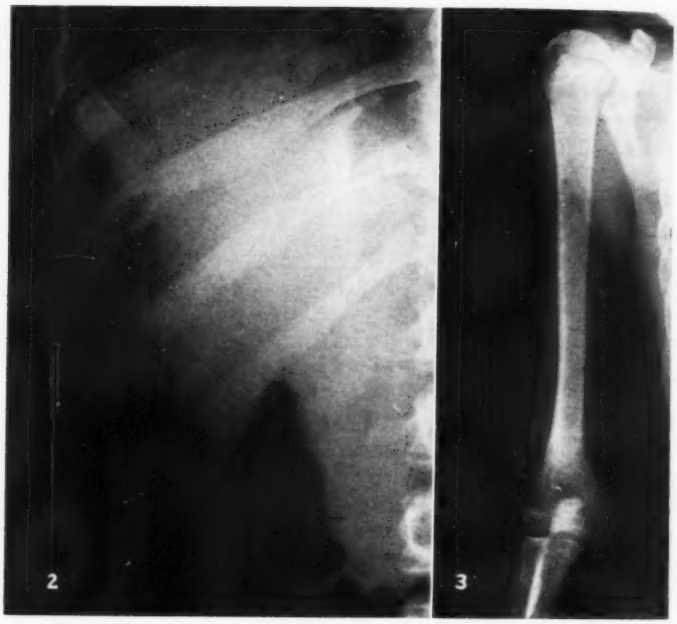


Fig. 2. Enlarged roentgenogram showing an oblong lytic defect in the tenth rib.

Fig. 3. Right humerus showing two cystic areas in the upper third. Note that these areas are eccentric and the internal cortex is slightly thinned. There is no periosteal new bone.

ETIOLOGY

The origin of lymphangioma is unknown, although Bickel and Broders note that the normal periosteum contains a rich plexus of lymphatic capillaries and that lymphatic vessels accompany the blood vessels in the haversian canals. The lesions may arise directly from these or may come from abnormal mesodermal rests which produce the imperfect lymphoid channels. Harris and Prandoni suggest that the disease could be due to a generalized metaplasia of the reticuloendothelial system in which some unknown factor changes the cells to produce lymphangiomas. This would postulate a relationship to conditions such as Hand-Schüller-Christian disease. Parsons and Ebbs (4) discuss this possibility. Infections and toxins could be related to the cellular alteration. Bickel and Broders state that their patient had chickenpox just before being seen. Bueno (5) has observed that certain cells of the reticuloendothelial system may be altered by toxic agents during infection and that the lymphatic tissue may be markedly altered. He reported increased swelling of a lymphangiomatous mass in the forearm following injection of diphtheria antitoxin. Any of these observations may prove to be significant in relation to skeletal lymphangiomatosis, but the resemblance of the progressive course to true neoplasm with the histologic lack of evidence of infection, at least now, seems most convincing. Our

case certainly has followed the course of multiple, benign bone tumors.

CLINICAL COURSE

Pain has been absent or mild except where other structures, especially the spinal nerves, are pressed upon, or where severe bone lysis interferes with structural mechanics. There is no mass until late, and even then it is less conspicuous than in almost any other condition causing an equal degree of bone destruction. There are no associated skin changes. Fever and leukocytosis are absent. Vertebral involvement, when quite advanced, produces the usual signs and symptoms of cord and nerve-root pressure. Pleural involvement may result in effusion and death from respiratory insufficiency. The spleen and the soft tissues of the extremities may show evidence of invasion. The most characteristic feature, common to all cases that have thus far been reported, is the slow but relentless progression of the bone lysis.

PATHOLOGY

In each case there have been found dilated lymphatic spaces and channels which destroy osseous tissue by pressure. In some instances the channels could be shown to communicate with the normal lymph spaces in the periosteum and surrounding soft tissues. In Bickel and Broders' case there was extension across the joint cartilage and into muscle. In Cohen and Craig's case the spleen contained multiple fibrous-walled cysts, some of which showed an endothelial lining. These had definite openings into the normal lymphatic channels.

Fig. 4. Multiple lytic areas involving both femora. In the distal third of the left femur there appears to be slight reactive sclerosis in addition to the rim of sclerosis. The cortex is bulged and thinned but not broken through. No periosteal bone is detected, even though the one area of thinning is very close to the cambium layer.

Fig. 5. Multiple lesions in the right tibia and fibula. The lesion in the upper third of the fibula has expanded and thinned the cortex, leaving only a thin rim of bone over it.

ROENTGEN APPEARANCE

The lesions are invariably lytic and usually well defined. There may be a thin zone of increased density resulting in a cystic appearance. In some cases the margin may have a soap-bubble contour, while in others it may be quite poorly defined and moth-eaten. Any surrounding sclerosis is never marked. Tangen-

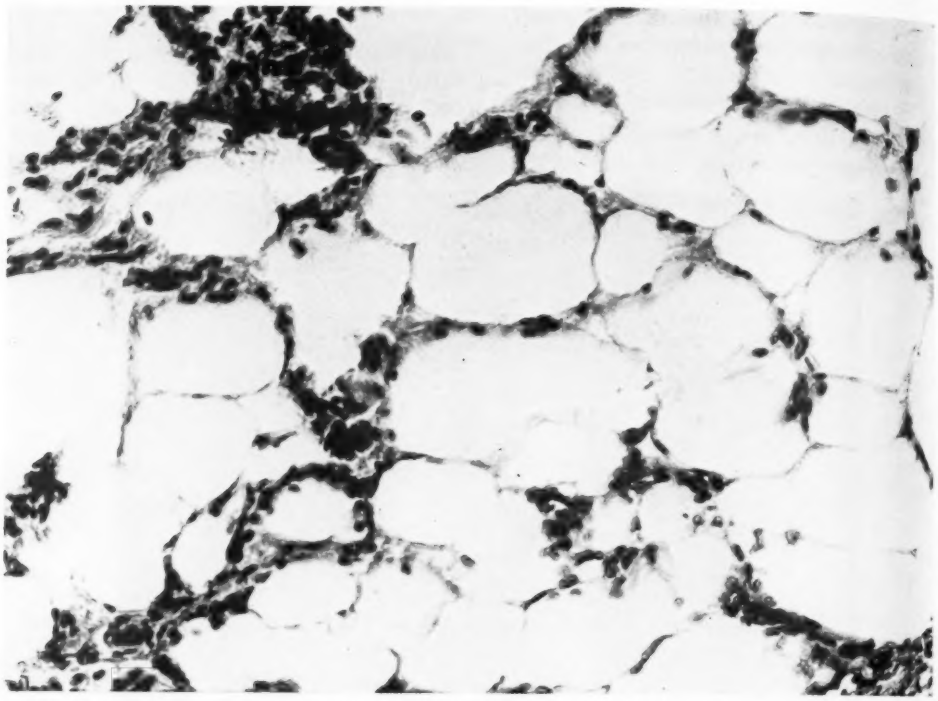


Fig. 6. Microscopic section shows dilated lymphatic channels which have caused pressure atrophy of osseous tissue.

tial views demonstrate thinning and some bulging of the cortex. Some parts may show complete absence of cortex, but there is no soft-tissue extension of calcium or bone. The size of the lesion varies from a few millimeters to as much as 15 cm. in diameter (Bickel and Broders' case finally involved the entire ilium). Almost all major bones have been affected, although lesions distal to the wrist and ankle have not been reported radiographically and the only autopsy (Cohen and Craig) did not include examination distal to these sites.

Radiographically there are a number of diseases which might present similar lytic bone lesions. Metastatic cancer, except for neuroblastoma, would be unlikely in so young an age group. The lesions of neuroblastoma are usually more diffuse and moth-eaten and less cystic and circumscribed. Complete lysis with structural collapse is seldom seen in that condition. Simple bone cysts are medullary and centrally expansile and rarely multiple. Solitary eosinophilic granulomata or multiple Schüller-Christian lesions might be impossible to differentiate. The single granuloma seldom becomes as large as these lymphangiomatous lesions. It is usually accompanied by more reaction in the surrounding bone and is not likely to be as cystic in appearance. In vertebrae the giant osteoid osteoma and aneurysmal bone cyst could probably be differentiated only by biopsy. The rare multiple hemangiomata have been mentioned as so similar to the lymphangiomata that differentiation is difficult even histologically.

TREATMENT AND PROGNOSIS

No treatment has been successful and so far the lesion has progressed in spite of irradiation, bone grafting, and repeated curettage. The course may be prolonged, and death may come after many years, only

when some vital structure, such as brain, spinal cord, or pleura, becomes injured by pressure or actual invasion. Surgical removal of the small localized lesion should be curative, but each of the reported cases has been beyond this stage upon discovery. Spontaneous regression has not been observed in any instance, nor has any lesion failed to undergo relentless progression.

SUMMARY

A case of multiple lytic lesions of bone due to ymphangiomata is reported. Although a rare disease, this must be added to the list of possible diagnoses in the presence of single and multiple cyst-like lytic defects seen in children. Histologically the defects are produced by the pressure atrophy of dilated lymphatic channels. Progressive enlargement of these channels, with increasing bone destruction, results in skeletal deformity, pressure effects, as in the spine, or extension to more vital structures such as the pleura. Early excision might be expected to be curative, but in the absence of pain each of the cases seen to date has been too advanced for this to be possible.

R. Parker Allen, M.D.
Children's Hospital
Denver, Colo.

REFERENCES

1. BICKEL, W. H., AND BRODERS, A. C.: Primary Lymphangioma of the Ilium; Report of a Case. J. Bone & Joint Surg. **29:** 517–522, April 1947.
2. COHEN, J., AND CRAIG, J. M.: Multiple Lymphangiectases of Bone. J. Bone & Joint Surg. **37-A:** 585–596, June 1955.
3. HARRIS, R., AND PRANDONI, A. G.: Generalized Primary Lymphangiomas of Bone; Report of Case Associated with Congenital Lymphedema of the Forearm. Ann. Int. Med. **33:** 1302–1313, November 1950.
4. PARSONS, L. G., AND EBBS, J. H.: Generalized Angiomatosis Presenting the Clinical Characteristics of Storage Reticulosis, with Some Observations on Reticulo-Endothelioses. Arch. Dis. Childhood **15:** 129–158, September 1940.
5. BUENO, P.: Reticuloendothelial Cells, Reacting to Toxic Antigens and to Infection. Arch. Path. **44:** 635–638, December 1947.

SUMMARIO IN INTERLINGUA

Lymphangioma de Osso

Es presentate un caso de multiple lesiones lytic de osso, causate per lymphangiomas. Ben que isto es un morbo rar, illo debe esser addite al lista del possibile diagnoses in le presentia de solitari o multiple cystoide defectos lytic vidite in juveniles. Histologicamente le defectos es producite per le atrophia per pression de dilatate canales lymphoidic. Le progressive allargamento de iste canales con le avantiamento del destruction de osso resulta in deformitate skeletic, effectos de pression, per exemplo in le columna dorsal, o extension verso structuras plus vital, como per exemplo le pleura. Il es possibile que un prompte excision esserea capace a curar le condition, sed viste le absentia de dolores, omne le casos usque nunc vidite esseva troppo avantiate pro permitter un tal manovra.

Fetal Tolerance to Radiation

A Case Report[1]

ALVARO RONDEROS, M.D.

MANY OBSERVATIONS indicate the harmful effects of large doses of radiation to man (3–5, 12–19). Occasionally, evidence is presented that such disastrous effects are not inevitable (7, 11, 12, 18). The purpose of this paper is to report an unusual case in which a large radiation dose was delivered to a human fetus without apparent damage. This child has been followed for eleven years.

CASE HISTORY

Mrs. M. H., a 40-year-old colored woman, gravida 11, para 10, was referred to the Tumor Clinic on May 19, 1949, with a pathological diagnosis of squamous-cell carcinoma of the cervix. She was about six and one-half months pregnant. The date of her last menstrual period was Oct. 22, 1948. Spotting had occurred in November and December, without associated pain or other symptoms. Fetal movements had been felt for seven weeks.

Physical examination was negative except for the gynecological findings. The cervix was enlarged and its anterior lip was granular in appearance, but this change seemed to be confined to the cervix. The uterus was of normal size for a pregnancy of six and one-half months.

Biopsies were taken at that time, and a recent review by the Pathology Department of the University Hospital confirms the initial diagnosis of squamous-cell carcinoma of the cervix. The decision of the members of the Tumor Clinic was to treat the carcinoma of the cervix and disregard the pregnancy. On May 24, 1949, external x-ray therapy was begun, through two anterior pelvic ports, 10 × 15 cm., and two posterior pelvic ports of the same size (Fig. 1). The beams were directed anteroposteriorly and dorsoventrally, respectively. Other factors were 200 kv, h.v.l. 1 mm. copper, target-skin distance 50 cm.

Before the delivery, the patient received a total dose of 1,400 r in air to each one of the anterior ports and 1,200 r in air to each of the posterior ports. The calculated mid-pelvis dose was 754 r in two weeks. External irradiation was supplemented by an application of radium on May 21, 1949: 36.66 mg. of radium in the form of a plaque sutured against the anterior lip of the cervix plus a Kaplan colpostat with 26.66 mg. in each side, totaling 90 mg. of radium, left in place for forty hours.

Fig. 1. Flat film of the abdomen showing outline of uterus (dotted line) and its relation to the radiation ports. (Reconstructed from data in files.)

On June 8, 1949, the fetus was in a right occipito-anterior position, and labor was induced. The next day the patient delivered a premature male child of entirely healthy appearance. The external x-ray therapy was continued after the delivery, with a second application, on July 19, of 60 mg. of radium, left for fifty hours.

The patient has been seen at the Tumor Clinic fourteen times between 1949 and 1959 by different observers, and no evidence of recurrent or metastatic tumor has been found. The usual local radiation reaction was observed in the immediate post-irradiation period and later stenosis of the vaginal vault developed.

I. H., who was born by induction of labor on June 8, 1949, is of scientific interest because of the apparent absence of damage from the aggregate large dose of x-ray and gamma radiation received during the sixth fetal month. His development has been normal, with no changes in the skin or eyes. He had normal dentition and walked and began speaking at the usual age. No physical or mental abnormality or retardation is revealed by the history.

A careful examination by the author on April 16, 1959, found an alert child who was physically and mentally normal for his age of eleven years. A

[1] From the Department of Radiology, Medical College of Alabama, Birmingham, Ala. Accepted for publication in August 1960.

radiological examination of the long bones and head failed to reveal any abnormality except for a small exostosis of the distal right femur. Routine laboratory studies of the blood and urine were normal (Fig. 2).

DISCUSSION

Many authors have emphasized the dangers of therapeutic radiation of the gravid uterus (1–5, 8, 9, 11). Murphy (14), in 1929, after an analysis of 625 women who had received therapeutic pelvic irradiation concluded that it "is extremely likely to be followed by the birth of a seriously defective off-spring." He felt that a pregnant uterus should never be subjected to radiation therapy. Most authors confirm these observations and agree on the disastrous consequences of the irradiation of embryos, consisting most commonly in microcephaly associated with mental deficiency (3, 4, 8, 9, 11, 16). Miller and associates (11) pointed out that these effects are proportional to the amount of radiation and are more serious in early pregnancies, though the fetus may be seriously injured at any stage of development. In an analysis of the delayed effects occurring within the first decade after the Hiroshima atomic explosion, Miller further concluded that the only harmful effects on human fetuses exposed to radiation is the limitation of growth, sometimes with associated mental retardation. These changes were more marked in the susceptible group of seven to fifteen weeks gestation.

Yamazaki *et al.* (18, 19), studying the Nagasaki group of pregnant women, demonstrated an overall fetal morbidity and mortality of 60 per cent in 30 cases and concluded definitely that radiation was of considerable importance in determining the outcome of these pregnancies. Whether the damage was due directly to fetal irradiation or indirectly as a result of its effects on the maternal tissue is not established.

The amount of radiation received by the fetus in our case is larger than the dose that Harris (5) found invariably to cause death of the human fetus of less than eighteen weeks gestation in his 200 cases. In the present instance the fetal age at the time of irradiation was twenty-six weeks and the dose was fractionated during a period of two weeks.

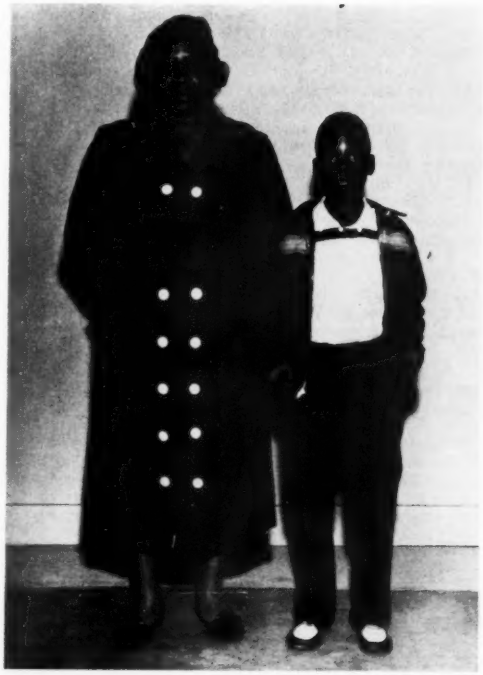


Fig. 2. Healthy mother and child ten years after pelvic irradiation for carcinoma of the cervix, during the sixth month of pregnancy.

SUMMARY

A forty-year-old female received therapeutic radiation during her eleventh pregnancy, for carcinoma of the cervix.

A calculated x-ray dose of 754 r in two weeks, plus 134 r from the radium source, was given to the center of the gravid uterus during the sixth month of fetal age.

A premature male infant was delivered by induced labor. This child, now eleven years of age, shows no evidence of physical or mental abnormality.

Calle 70A 7–62
Bogotá, Colombia, S.A.

REFERENCES

1. BAGG, H. J., AND LITTLE, C. C.: Hereditary Structural Defects in Descendants of Mice Exposed to Roentgen-Ray Irradiation. Am. J. Anat. **33:** 119–145, March 1924.

2. BONNEVIE, K.: Embryological Analysis of Gene Manifestation in Little and Bagg's Abnormal Mouse Tribe. J. Exper. Zool. **67:** 443–520, 1934.

3. GLASS, S. J.: Dwarfism Associated with Microcephalic Idiocy and Renal Rickets. J. Clin. Endocrinol. **4:** 47–53, February 1944.

4. GOLDSTEIN, L., AND MURPHY, D. P.: Microcephalic Idiocy Following Radium Therapy for Uterine Cancer During Pregnancy. Am. J. Obst. & Gynec. **18:** 189–195, August 1929.

5. HARRIS, W.: Therapeutic Abortion Produced by Roentgen Ray. Am. J. Roentgenol. **27:** 415–419, March 1932.

6. HOBBS, A. A., JR.: Fetal Tolerance to Roentgen Rays. A Case Report. Radiology **54:** 242–246, February 1950.

7. JONES, H. W., JR., AND NEILL, W., JR.: Treatment of Carcinoma of the Cervix During Pregnancy. Am. J. Obst. & Gynec. **48:** 447–463, October 1944.

8. LAMY, M., AND JAMMET, M. L.: Notes cliniques sur un cas d' "enfant du radium." Acta Paediat. **36:** 208–214, 1948.

9. MAXFIELD, F. N.: Case of Microcephaly Following Prenatal Roentgen Irradiation. Am. J. Ment. Deficiency **45:** 358–365, January 1941.

10. MAYER, M. D., HARRIS, W., AND WIMPFHEIMER, S.: Therapeutic Abortion by Means of X-Ray. Am. J. Obst. & Gynec. **32:** 945–957, December 1936.

11. MILLER, J. R., CORSCADEN, J. A., AND HARRAP, J. A.: The Effects of Radiation on the Human Offspring. Present-Day Views. Am. J. Obst. & Gynec. **31:** 518–522, March 1936.

12. MILLER, R. W.: Delayed Effects Occurring within First Decade After Exposure of Young Individuals to Hiroshima Atomic Bomb. Pediatrics **18:** 1–17, July 1956.

13. MURPHY, D. P.: Ovarian Irradiation; Its Effect on Health of Subsequent Children; Review of Literature, Experimental and Clinical, with Report of 320 Human Pregnancies. Surg., Gynec. & Obst. **47:** 201–215, August 1928.

14. MURPHY, D. P.: Outcome of 625 Pregnancies in Women Subjected to Pelvic Radium or Roentgen Irradiation. Am. J. Obst. & Gynec. **18:** 179–187, August 1929.

15. NEEL, J. V., AND OTHERS: Effect of Exposure to Atomic Bombs on Pregnancy Termination in Hiroshima and Nagasaki: Preliminary Report. Science **118:** 537–541, Nov. 6, 1953.

16. PENROSE, L. S.: Effects of Radiation on the Outcome of Pregnancy. Pub. Health **71:** 217–220, September 1957.

17. RICH, J., ANGRIST, A., AND CARPENTER, F.: Effect of Radiation on Products of Conception in Case of Carcinoma of Cervix Complicating Pregnancy. New York State J. Med. **51:** 2166–2168, Sept. 15, 1951.

18. YAMAZAKI, J. N., WRIGHT, S. W., AND WRIGHT, P. M.: Symposium on Effects of Radiation and Other Deleterious Agents on Embryonic Development; Study of Outcome of Pregnancy in Women Exposed to Atomic Bomb Blast in Nagasaki. J. Cell. & Comp. Physiol. (Supp. 1) **43:** 319–328, May 1954.

19. YAMAZAKI, J. N., WRIGHT, S. W., AND WRIGHT, P. M.: Outcome of Pregnancy in Women Exposed to Atomic Bomb in Nagasaki. Am. J. Dis. Child. **87:** 448–463, April 1954.

SUMMARIO IN INTERLINGUA

Tolerantia Fetal pro le Radiation: Reporto de un Caso

Un femina de color de 42 annos de etate, pregnante depost sex menses e medie, esseva tractate per irradiation externe e applicationes de radium pro un pathologicamente demonstrate carcinoma a cellulas squamose in le cervice. Le dosage de roentgen ante le parturition amontava a un total de 1.400 r (in aere) a cata un del duo portas anterior e de 1.200 r a cata un del duo portas posterior. Le dose mesopelvic esseva calculate como 754 r. Isto esseva augmentate per 134 r abun interne fonte de radium. Nulle signo de injuria in le feto esseva evidente al parturition o in le curso de un periodo de dece-un annos de observationes subsequente.

Le matre recipeva additionalmente therapia a radios roentgen e a radium post le nascentia del infante e habeva experientiate nulle recurrentia del carcinoma dece-un annos plus tarde.

Osteogenesis in Multiple Myeloma

Report of a Case[1]

EDWARD C. PORTER, M.D.

IT HAS BEEN generally accepted that untreated, uncomplicated myeloma does not usually produce periosteal reaction (1-3). There have been, however, a few scattered reports in the literature of myeloma associated with osteogenesis. Krainin, D'Angio, and Smelin (4) in 1949 reported the case of a sixty-eight-year-old female with multiple myeloma with extensive new bone formation involving the humerus, accompanied by a fracture in one portion of the shaft. A more recent example (1958) is recorded by Lewin and Stein (5), whose patient was a forty-eight-year-old male with solitary spinal involvement showing new bone formation.

Certainly osteogenesis is only rarely encountered in multiple myeloma. The purpose of this paper is to add one report to the meager list of such cases.

A 67-year-old white woman entered the hospital because of swelling of the left mandible, left cheek, and left forehead of two months duration. She had recently undergone tooth extraction and swelling had persisted after removal of the tooth. The past history and system review were not contributory. On physical examination, moderate swelling over the anterior portion of the left mandible, as well as around the left eye, was obvious. Some irregularities of the calvarium could be felt. No particular tenderness was noted in the involved areas.

Roentgen examination demonstrated multiple discrete areas of bone destruction involving the skull (Figs. 1 and 2). There were, however, areas of periosteal new bone formation along the ramus of the left mandible and particularly in the left frontal bone at the site of a large osteolytic defect (Fig. 3). Because of the osteogenic activity, a diagnosis of metastatic sarcoma of undetermined type was entertained.

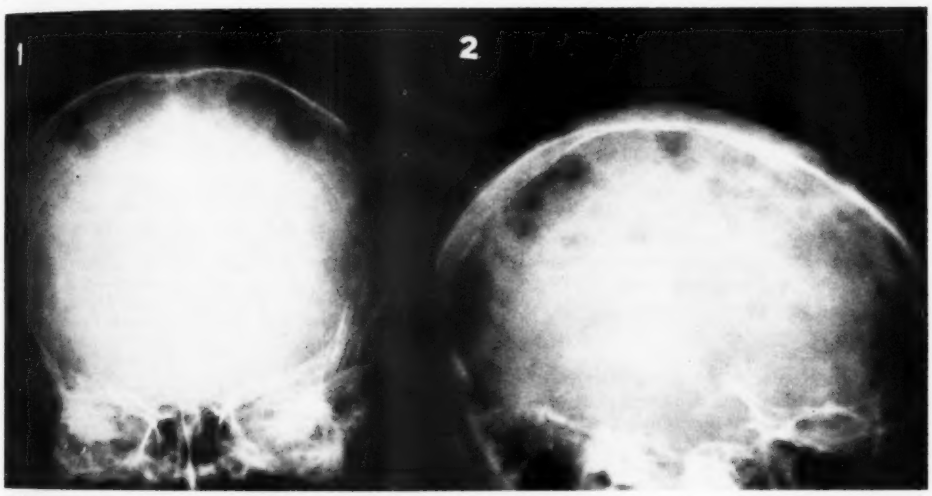


Fig. 1. Anteroposterior film of skull demonstrating multiple osteolytic defects. Area of greatest osteogenesis (enlargement shown in Fig. 3) is in left frontal area.
Fig. 2. Lateral view showing extent of lesions.

Shortly thereafter a biopsy of the left mandible was carried out and the report of the pathologist included the following statements: "The tumor is composed of undifferentiated, closely packed cells with moderately hyperchromatic nuclei. The amount of cytoplasm varies considerably. Little or no cytoplasm is found in the more compact areas of the tumor.... Rather marked osteoblastic activity

[1] From the Department of Radiology, Eastern Maine General Hospital, Bangor, Maine. Accepted for publication in July 1960.

Fig. 3 Coned-down spot-film of area of greatest osteogenic activity in left frontal region of skull.

in many parts of the bony fragments is present. In some places there is heaping of many layers of osteoblasts. There is evidence of new bone formation. There are no areas of poorly formed osteoid tissue or poorly formed cartilaginous tissue such as is frequently seen in osteogenic sarcoma."

A diagnosis of malignant tumor, probably of mesenchymal origin, was made.

Following this, the patient was referred elsewhere. Additional studies included sternal marrow puncture, which revealed large numbers of myeloma cells, and paper electrophoresis showing abnormal globulin beyond the range of gamma globulin, which was interpreted as abnormal myeloma globulin.

Other laboratory findings were as follows: hemoglobin 11.3 gm., hematocrit 34 per cent; sedimentation rate 51 mm.; white corpuscles 10,300 (polymorphonuclears 34, non-segmented cells 9, lymphocytes 30, monocytes 9, metamyelocytes 3); plasma cells 5; prothrombin time 82 per cent; blood calcium 9.4 mg. per 100 c.c.; phosphorus 3.4 mg. per 100 c.c.; alkaline phosphatase 4.4 Bodansky units; total protein 9.7 gm. per 100 c.c. (albumin 4; globulin 5.1.). Urinalysis was reported as showing: specific gravity, 1.020, albumin 3+, Bence-Jones protein.

A diagnosis of multiple myeloma was made and the patient was referred for urethane and radiation therapy.

It is interesting to note the lack of appreciable elevation of the alkaline phosphatase, calcium, and phosphorus levels in this case, despite the presence of pronounced osteogenesis, demonstrated both radiographically and histologically.

SUMMARY

A case is reported of multiple myeloma, untreated and without pathological fracture, but showing marked new bone formation.

489 State Street
Bangor, Maine

REFERENCES

1. LUCK, J. V.: Bone and Joint Diseases: Pathology Correlated with Roentgenologic and Clinical Features. Springfield, Ill., Charles C Thomas, 1950.
2. COLEY, B. L., AND HIGINBOTHAM, N. L.: Tumors of Bone: A Roentgenographic Atlas. Annals of Roentgenology, Vol. XXI. New York, Paul B. Hoeber, Inc., 1953.
3. MESCHAN, I.: Roentgen Signs in Clinical Diagnosis. Philadelphia, W. B. Saunders Co., 1956.
4. KRAININ, P., D'ANGIO, C. J., AND SMELIN, A.: Multiple Myeloma with New Bone Formation. Arch. Int. Med. **84:** 976–982, December 1949.
5. LEWIN, H., AND STEIN, J. M.: Solitary Plasma Cell Myeloma with New Bone Formation. Am. J. Roentgenol. **79:** 630–637, April 1958.
6. RUNDLES, R. W., AND REEVES, R. J.: Multiple Myeloma. II. Variability of Roentgen Appearance and Effect of Urethane Therapy on Skeletal Disease. Am. J. Roentgenol. **64:** 799–809, November 1950.

SUMMARIO IN INTERLINGUA

Osteogenese in Myeloma Multiple: Reporto de un Caso

Es reportate un caso de myeloma multiple, non tractate e non monstrante fractura pathologic, sed con neoformation de osso. Le examine radiographic demonstrava multiple areas discrete de destruction de osso afficiente le cranio. Esseva presente, tamen, areas de neoformation periostee al longo del ramo del mandibula sinistre e particularmente in le osso sinistro-frontal al sito de un grande defecto osteolytic. A causa del activitate osteogene, un diagnose de sarcoma metastatic esseva considerate. Tamen, myeloma esseva demonstrate in studios laboratorial.

Dose to the Eye from Radiographic Procedures[1]

ELIZABETH F. FOCHT, B.A., GEORGE R. MERRIAM, Jr., M.D.,
MARY BARNES, A.B., and JOHN A. EVANS, M.D.

THE QUESTION has frequently arisen concerning the amounts of radiation delivered to the lens from various diagnostic x-ray procedures. The study to be reported here was undertaken to measure, by means of a special phantom, the dose to the eye for those standard examinations in which the eye is in the direct beam.

The phantom (Fig. 1) employed was the one used previously in studies of radiation cataracts (1) and in determination of the dose delivered to the lens in the radiation therapy of tumors of the head (2). It was a skull of average size coated with a mixture of equal parts of paraffin and beeswax, of unit density. Bolus was used to fill the cranial cavity. Plastic eyes, of unit density, were constructed, with a hole drilled to fit the 25-r Victoreen condenser ionization chamber.

The chamber was checked against others calibrated at the Bureau of Standards. It was found to have a factor constant within ±5 per cent over the range of qualities used, from h.v.l. 0.5 mm. Al to 3.0 mm. Al. The intensity limit of this chamber is 15 r per second on the Victoreen Model 70 electrometer. The milliamperes were always adjusted to such a level that this limit was not exceeded. Since the roentgens per film were so few, multiple exposures were made and the total reading divided by the number of exposures to give the individual figure.

The phantom was set up according to standard technics used for the various diagnostic studies. In each instance the axis of the chamber was placed, as nearly as possible, perpendicular to the beam. This was done to avoid directional effects.

The results for the general radiographic views are listed in Table I in which are shown the type of radiograph, the technical factors upon which the dose depends, the target-film distance, the size of the field, and the measured dose to the lens in roentgens for the eye nearer the tube. Because of normal variations in the size and configuration of human skulls, together with differences in the outputs of various types of diagnostic machines for the same stated values of kilovoltage, milliampere seconds, and filter, the results have been rounded off to the nearest tenth of a roentgen or, if less than a tenth, to the nearest hundredth. Most of the values were measured, but for small changes in milliampere seconds, distance, or kilovoltage, the doses were calculated from the closest measured values.

Fig. 1. Phantom head showing ionization chamber and dental x-ray machine set-up.

[1] From the Department of Radiology, New York Hospital-Cornell Medical Center, New York (E. F. F.; J. A. E.) and the Institute of Ophthalmology, Columbia-Presbyterian Medical Center, New York (G. R. M.; M. B.). This work was supported in part by a grant from the Snyder Ophthalmic Foundation. Accepted for publication in August 1960.

TABLE I: DOSE TO EYE FROM DIAGNOSTIC FILMS
(With no Al added, the total filtration is 0.5 mm. Al inherent)

View	kv	mas	Field Size at Film	—Roentgens— No Al added	2 mm. Al added	Remarks
Target-Film Distance 36 Inches						
Skull						
Towne	86	50	10″ width	0.6	0.4	
Caldwell	82	50	10″ width	0.02	0.02	
Lateral	68	50	10″ square	0.7	0.3	Eye nearer film = 0.09 r for 2.0 mm. Al
Submental	84	75	10″ width	0.5	0.3	
Anteroposterior	76	50	14″ circle	2.2	0.6	
Sinuses						
Caldwell	80	50	7″ diameter	0.02	0.02	
Waters	82	50	7″ circle	0.05	0.04	
Lateral	62	50	7″ circle	0.6	0.2	Eye nearer film = 0.09 r for 2.0 mm. Al
Submental	86	50	10″ width	0.3	0.2	
Orbits	88	50	10″ square	0.05	0.05	
Optic foramen	76	50	10″ square	0.03	0.03	Total to each eye for 2 exposures = 0.05 r for 2.0 mm. Al
Foreign body						
Lateral	40	60	10″ square	0.2	0.04	
Mastoids						
Towne	86	50	10″ width	0.6	0.4	
Mayer	84	50	10″ width	0.4	0.1	
Law	70	50	10″ width	0.4	0.2	
Nose						
Waters	88	50	10″ square	0.05	0.05	
Lateral	50	100	10″ square	0.9	0.2	
Occl. sup. inf.	50	50	10″ square	0.07	0.03	
Zygoma						
Towne	82	50	10″ width	0.5	0.3	
Waters	88	50	10″ square	0.05	0.05	
Submental	84	50	10″ width	0.3	0.2	
Maxilla						
Waters	88	50	10″ square	0.05	0.05	
Occl. sup. inf.	56	100		0.5	0.2	
Temporomandibular joints						
Lateral; open and closed; right and left	72	50	10″ width	0.6	0.2	With 2.0 mm. Al: eye nearer film = 0.04 r; total to each eye for 4 exposures = 1.2 r

The first column lists the radiographic examinations. All were standard views for which average technics for a medium-sized adult head were used. The distance is that from the target to the film. The distance to the eye would always be less. The two fields used most frequently were delineated by a diaphragm or a disk. The diaphragm consisted of a lead plate measuring 1.5 by 1.5 inches, located about 5 inches from the target. This gave approximately a 10-inch square at the film at 36 inches. The lead disk had a circular opening just over 4 inches in diameter. This was used at a distance of 22 inches from the target and gave a 7-inch field on the film. These were the standard devices routinely employed in the department on a special head unit.

The inherent filtration of the unit was 0.5 mm. Al, to which is added 2.0 mm. Al for regular use. In order to show the protective value of this added filtration, measurements were made with and without it. These readings were made with the same kilovoltage to show the maximum difference. Had the kilovoltage been reduced slightly when the filter was removed the values would, of course, have been somewhat lower—about 10 per cent for a reduction of 4 kv at the higher kilovoltages.

In some cases, readings were taken to show the difference with and without a

TABLE I: DOSE TO EYE FROM DIAGNOSTIC FILMS.—*cont.*
(With no Al added, the total filtration is 0.5 mm. Al inherent)

View	kv	mas	Field size at film	—Roentgens— No Al added	2 mm. Al added	Remarks
Target-Film Distance 36 Inches						
Facial bones						
Caldwell	76	50	10″ width	0.02	0.02	
Waters	88	50	10″ square	0.05	0.05	
Lateral	64	50	10″ square	0.6	0.2	
Petrous bone						
Towne	78	50	10″ width	0.5	0.3	
Mandible						
Caldwell	82	50	10″ width	0.03	0.02	
Waters	88	50	10″ square	0.05	0.05	
Lateral-oblique	64	50	10″ width	0.4	0.1	
Submental	82	50	10″ width	0.3	0.2	
Occl. submental	58	100	10″ width	0.3	0.1	
Carotid arteriogram						
Anteroposterior	94	100	11 × 14″	5.2	1.3	
	86	100	11 × 14″	4.5	1.0	
Lateral	74	100	10 × 12″	2.5	0.7	
Serial carotid arteriogram						
Lateral	70	40	12 × 12″	0.9	0.3	11 r for 12 films, with no Al; 3 r for 12 films, with 2.0 mm. Al
Anteroposterior	90	40	12 × 12″	2.0	0.4	24 r for 12 films, with no Al; 5 r for 12 films, with 2.0 mm. Al
Target-Film Distance 40 Inches						
Pneumotomogram, eye						
Postero-anterior	66	100	14″ circle	0.04	0.04	For 8 cuts = 0.30 r with and without Al
Lateral	58	100	14″ circle	0.8	0.4	For 7 cuts = 5.7 r with no Al; = 2.6 r with 2.0 mm. Al
Target-Film Distance 34 Inches						
Pneumoventriculogram						
Anteroposterior	85	50	14″ diameter	..	1.6	
Postero-anterior	85	50	14″ circle	..	0.1	
Lateral	75	50	14″ circle	1.0	0.4	

field-limiting device. As would be expected, with a larger field the per cent back-scatter to the eye for the anteroposterior view or the increased scatter at a depth for the postero-anterior view make the readings greater for the same factors. This could almost double the dose, as in the postero-anterior Waters view of the sinuses, with and without the lead disk.

As can be seen, none of the diagnostic procedures delivered significant amounts of radiation to the lens. The largest dose for a routine procedure with 2 mm. added filter was about 0.6 r for a single exposure if an anteroposterior skull view were taken. With no added filtration, the dose to the lens was about 2.2 r. The largest dose for a special procedure, single exposure, was 5.2 r for an anteroposterior carotid arteriogram, without the added filter. With filtration the dose would have been 1.3 r.

The largest dose for a multiple exposure examination was for serial cerebral arteriography with the rapid roll-film changer. When the recommended 2 mm. Al filter was used, the dose was 8 r for the twenty-four exposures constituting a complete study. Without the added filtration, the dose was 35 r for the same number of films.

In some dental examinations, where the eye was near or just outside the edge of the beam, measurements were taken for two technics, both at 65 kv and 7.5 mas

TABLE II: DOSE TO EYE FROM DENTAL FILMS
(With no Al added, the total filtration is 0.5 mm. Al inherent)

View	kv	mas	Field Size at film	Roentgens: No Al added	Roentgens: 1 mm. Al added	Remarks
Target-Film Distance 8 Inches						
Upper Molar	65	7.5	3 1/2″ diameter	..	0.02	Other eye 0.02
	65	7.5	5 1/4″ diameter	2.4	..	Other eye 0.02
Upper Bicuspid	65	7.5	3 1/2″ diameter	..	1.0	Other eye 0.02
	65	7.5	5 1/4″ diameter	3.2	..	Other eye 0.05
Upper Cuspid	65	7.5	3 1/2″ diameter	..	0.07	Other eye 0
	65	7.5	5 1/4″ diameter	2.5	..	Other eye 0.1
Incisor	65	7.5	3 1/2″ diameter	..	0.05	Other eye 0.05
	65	7.5	5 1/4″ diameter	0.2	..	Other eye 0.2
Maxillary Occlusal	65	7.5	3 1/2″ diameter	..	0.6	Other eye 0.6
	65	7.5	5 1/4″ diameter	1.5	..	Other eye 1.5
Lower Biscuspid	65	7.5	3 1/2″ diameter	..	0.01	Other eye 0.01
	65	7.5	5 1/4″ diameter	0.4	..	Other eye 0.3

for each exposure. One used only the inherent filtration of 0.5 mm. Al, giving a h.v.l. of 0.5 mm. Al, with no extra field-limiting device. It gave a field size of 5 1/4 inches at 7 inches target distance. The other technic added 1 mm. Al filter, giving a total of about 1.5 mm. Al filtration. A lead diaphragm was used to restrict the field to a 3 1/2 inch circle at the end of the plastic dental cone, at 7 inches from the target. The latest Protection Handbook (3) recommendation is not more than 3 inches at the cone tip.

The readings for both technics are shown in Table II. The doses are given to both eyes. The only measurement shown for the lower jaw is the bicuspid, since this gave the highest readings to the eyes. Except in the case of the upper bicuspid film, it was possible to exclude the eye from the direct beam by the use of the lead diaphragm.

In the usual full-mouth series, consisting of 14 films—molars, bicuspids, cuspids, and incisors—the roentgens per film were never more than 3.2 r for 0.5 mm. Al total and a large field, or 1.0 r for 1.5 mm. Al total and a 3 1/2 inch field. The maximum dose to each eye for a full-mouth series, with the former technic, would be about 11 r. When the latter technic was employed, the dose would be approximately 1.2 r.

During fluoroscopy the eye of the patient was not expected to be in the direct beam. To determine the dose to the fluoroscopist, two of the residents wore 200-mr pocket dosimeters on their foreheads during barium-enema and gastrointestinal examinations. The units had 2 mm. added Al and the field sizes were smaller than the screen. Measurements were taken for eighteen days, with total "on" times each day from several to forty minutes. The largest reading found for a single day was 1 mr.

None of the doses to the lens, even for repeated exposures, approaches cataractogenic levels. In a previous study (1) the smallest cataractogenic dose found for a single treatment was 200 r. This produced a minimal, localized stationary opacity. When the treatment time was extended over a period of three weeks to three months the minimum cataractogenic dose found was 400 r. This also produced a small stationary cataract. When the exposure exceeded three months, the minimum cataractogenic dose found was 550 r. It is extremely unlikely, therefore, that a cataract would develop from any of the usual diagnostic procedures, even with repeated exposures. Since, as far as is known, the lens is the most radiosensitive ocular structure, it is unlikely that any other damage to the eye would result.

REFERENCES

1. MERRIAM, G. R., JR., AND FOCHT, E. F.: A Clinical Study of Radiation Cataracts and the Relationship to Dose. Am. J. Roentgenol. **77**: 759–785, May 1957.
2. MERRIAM, G. R., JR., AND FOCHT, E. F.: Radiation Dose to the Lens in Treatment of Tumors of the Eye and Adjacent Structures. Possibilities of Cataract Formation. Radiology **71**: 357–369, September 1958.
3. Medical X-Ray Protection Up to 3 Million Volts. Washington, D. C., National Bureau of Standards Handbook 76 succeeding Handbook 60.

The New York Hospital—Cornell Medical Center
525 East 68th Street
New York 21, N. Y.

SUMMARIO IN INTERLINGUA

Dosage al Oculo in Manovras Radiographic

Con le adjuta de un phantoma previemente usate in le studio de cataractas de radiation, mesurationes del dosage de radiation esseva effectuate que es recipite per le oculo in le curso de varie manovras radiographic dirigite al capite e al collo. Le inherent filtration del apparato usate esseva 0,5 mm de aluminium. Le mesurationes esseva executate tanto con como etiam sin un filtration additional de 2,0 mm de aluminium.

Le doses associate con varie manovras es tabulate. Nulle del doses recipite per le lente—mesmo in caso de repetite expositiones—esseva proxime a nivellos cataractogene. In vista de previe studios, il pare extrememente improbabile que un cataracta se disvelopparea in consequentia de ulle del usual manovras diagnostic, mesmo post repetite expositiones. Proque le lente —in tanto que on lo sape—es le structura ocular le plus radio-sensibile, il es improbabile que ulle altere damno al oculo resultarea.

Experimental Comparison of Ortho-Iodohippuric Acid and Iodopyracet in Renal Function Evaluation[1]

JOSEPH E. WHITLEY, M.D., RICHARD L. WITCOFSKI, M.S., and I. MESCHAN, M.D.

THE first iodine-131-tagged compound used in evaluation of renal function was iodopyracet (Diodrast). Taplin *et al.* (1) in 1956 reported a study of renal function in rabbits with this compound and Winter (2) obtained iodopyracet I^{131} renograms in man. In both of these studies analysis of the results was attempted through a comparison of the curves obtained from the two kidneys in the same individual. Almost from the outset it was recognized that a variable percentage of the Diodrast was being taken up by the liver and bound in the plasma, making this type of comparison difficult (3, 4).

Caudal angulation of the scintillation probes and use of carrier Diodrast were both attempted to obviate these difficulties. In our hands neither of these methods has been thought to be uniformly successful.

Ortho-iodohippuric acid has recently become commercially available[2] and we have subjected it to laboratory analysis in the dog, comparing it to iodopyracet.

METHOD AND RESULTS

Dogs were anesthetized with pentobarbital sodium administered intravenously. The animals were strapped in the supine position and an incision was made from the xiphoid to the pubis. Cystotomy was performed and ureteral catheters were passed bilaterally. The femoral artery was cannulated (and in some cases the renal vein) and external probes were positioned over the kidneys. The counting unit employed consisted of two collimated scintillator probes (1 1/2 × 1-inch NaI crystals), matched ratemeter units, and a dual rectilinear chart recorder. Twenty microcuries of either iodopyracet or ortho-iodohippuric acid was used throughout. Physiologic saline was administered intravenously to assure a good urine output.

TABLE I: DATA COMPARING IODOPYRACET AND ORTHO-IODOHIPPURIC ACID INJECTIONS IN THE DOG

Measured Quantity	Diodrast (N = 14)	Ortho-iodohippuric Acid (N = 14)	Probabilities That the Differences in the Means Are Due to Random Variation
Half secretion time (min.)	1.1 ± 0.2	1.3 ± 0.2	$P < 0.020$
Half excretory time (min.)	5.5 ± 0.4	3.7 ± 1.3	*$P < 0.001$
Half urine appearance time (min.)	7.5 ± 1.8	8.0 ± 2.0	$P > 0.50$
Half blood clearance time (min.)	2.4 ± 1.5	5.2 ± 2.2	$P < 0.001$
Time of secretory peak (min.)	3.4 ± 0.7	4.2 ± 1.3	$P < 0.001$
B/A (arbitrary units)	0.48 ± 0.23	0.44 ± 0.11	*$P > 0.50$

* The inhomogeneity in the variances of the two groups yield an F factor greater than 5 per cent. Therefore, the probabilities were calculated with (N-1) degrees of freedom rather than 2(N-1).

Minute blood samples, external radiocardiograms, minute urine collections from each kidney, and renograms were obtained simultaneously. Typical findings are shown in Figure 1.

A comparison between the liver uptake of iodopyracet and ortho-iodohippuric acid was attempted with serial renal and liver biopsies at three-minute intervals. In order to rule out inhomogeneity within organs, 12 dogs were sacrificed at approximately three, seven, and fifteen minutes and total organ counts were performed on the liver, right kidney, left kidney, spleen, and thyroid. With this method inhomogeneity was discovered in the distribution of the compounds in both the liver and the

[1] From the Department of Radiology (J. W., Fellow in Radiological Research of the James Picker Foundation; R. W., Physicist; I. M., Professor and Director), Bowman Gray School of Medicine, Winston-Salem, N. C. This project was supported by National Institutes of Health Grant #RG-4999, The North Carolina Heart Association, and H. T. S. 5392, National Institutes of Health. Accepted for publication in August 1960.

[2] E. R. Squibb & Sons, New York, N. Y.

kidneys (comparing aliquot and total organ assay). The thyroid and spleen uptakes were insignificant. The pertinent results are presented in Figure 2.

The two compounds were compared in 28 dogs with the probes in close proximity to the renal masses (*via* the laparotomy wound). The results, analyzed as to slope and half-time (with a Dietzgen compensating planimeter), are shown in Table I, given as mean times ± one standard deviation. Figure 3 illustrates our reference points on a schematic renogram. B/A is a fraction obtained by comparing the height of the peak concentration of the renal mass above the inflow activity level with the inflow activity level. This number reflects one parameter of renal work.

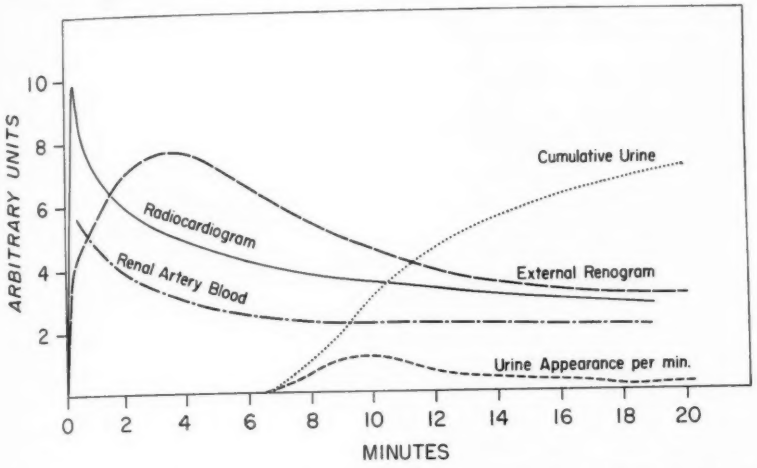


Fig. 1. An external renogram with examples of other representative curves obtained with this experimental method.

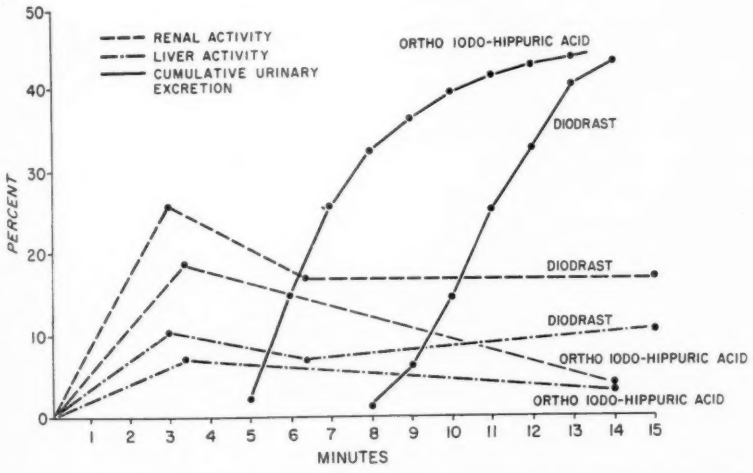


Fig. 2. Total organ activity at various times, with iodopyracet and ortho-iodohippuric acid.

It is apparent from Figure 1 that the serial blood samples and the external radiocardiogram give the same information.

A comparison of injections of iodopyracet and ortho-iodohippuric acid sequentially in the same animal and in groups of ani-

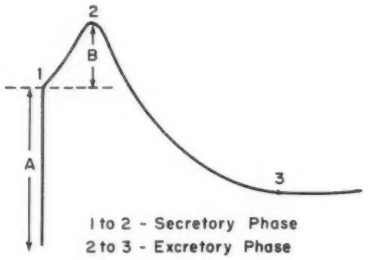


Fig. 3. A schematic renogram demonstrating the reference points used in the renogram analysis.

mals demonstrated that the *principal* difference between the two compounds, when employed for external renograms, was the hepatic uptake of Diodrast. The liver uptake of iodopyracet is significantly higher than that of ortho-iodohippuric acid and continues to increase slowly during the fifteen-minute test period. The hepatic radioactivity following a dose of ortho-iodohippuric acid parallels the splenic curve (passive to the compound) and is thought to reflect only the vascularity of the liver.

The greater specificity of the ortho-iodohippuric acid molecule for renal excretion makes it the better medium for external analysis of kidney function. In carrying out this examination in man, we are impressed with the lack of need for compensation for hepatic uptake. The curves obtained with the new compound are more easily interpreted than are those of iodopyracet and its rate of excretion appears more rapid in dogs and in man than those of Miokon and Hypaque as quoted in the literature (7).

The study of right and left renal curves shielded from the liver in the 28 dogs (Table I) demonstrated:

1. A small but significant difference in the half-secretion time, iodopyracet being handled more rapidly.
2. A significantly shorter half-excretory time of ortho-iodohippuric acid.
3. A significantly shorter half-blood clearance time of iodopyracet (due to hepatic uptake?)
4. A significantly later secretory peak of ortho-iodohippuric acid.
5. No statistical difference between the two compounds in half-urine appearance time and the ratio of B/A.

CONCLUSIONS

A comparison of injections of iodopyracet I^{131} and iodohippuric acid I^{131} injected in dogs demonstrated greater specificity of the latter for renal excretion and no loss in the rapidity of excretion.

Certain differences between the renogram patterns of the two compounds are described.

Bowman Gray School of Medicine
Winston-Salem 7, N. C.

REFERENCES

1. TAPLIN, G. V., MEREDITH, O. M., JR., KADE, H., AND WINTER, C. C.: Radioisotope Renogram; External Test for Individual Kidney Function and Upper Urinary Tract Patency. J. Lab. & Clin. Med. **48**: 886–901, December 1956.
2. WINTER, C. C.: A Clinical Study of a New Renal Function Test: The Radioactive Diodrast Renogram. J. Urol. **76**: 182–196, August 1956.
3. TAPLIN, G. V., MEREDITH, O. M., JR., KADE, H., AND WINTER, C. C.: The Radioisotope Renogram. An External Test for Individual Kidney Function and Upper Urinary Tract Patency. J. Lab. & Clin. Med. **48**: 886–901, December 1956.
4. BLOCK, J. B., AND BURROWS, B. A.: Renal Clearance of I^{131} Diodrast at Low Plasma Concentrations. J. Clin. Res. **6**: 284, April 1958.
5. WINTER, M.: The Use of p-Aminohippuric Acid for the Evaluation of Renal Function. Acta med. scandinav. **163**: 161–165, Feb. 25, 1959.
6. DENNEBERG, T., AND HEDENSKOG, L.: The Radioactive Hypaque Renogram. Assessment of Renal Function with Automatic External Scintillation Detection Equipment. Acta med. scandinav. **165**: 61–70, Sept. 30, 1959.
7. WINTER, C. C., AND TAPLIN, G. V.: A Clinical Comparison and Analysis of Radioactive Diodrast, Hypaque, Miokon and Urokon Renograms as Tests of Kidney Function. J. Urol. **79**: 573–579, March 1958.

(Pro le summario in interlingua, vider le pagina 471)

An Automatic Device for Voiding Urethrography in Infants and Small Children

J. SCOTT DUNBAR, M.D., F.R.C.P. (C), RICHARD B. GOLDBLOOM, M.D., F.R.C.P. (C), VICTOR POLLOCK,[2] and REX RADFORD, S.R.N., M.S.R. (R).

ADEQUATE radiological investigation of the lower urinary tract in infants and small children has always been hampered by the difficulty in obtaining voiding urethrograms, due to lack of cooperation on the part of the young patients.

In recent years, the value of voiding urethrography has been widely recognized and increasingly exploited. The excretory method, utilizing the opacification of the bladder during intravenous pyelography, has particular advantages, in that the bladder and urethra can be visualized without the necessity of instrumentation. The importance of this procedure, as well as the difficulty of such an examination in infancy, is illustrated by a recent paper by Hope and his associates (1).

The purpose of this report is to present an apparatus which makes it possible to obtain satisfactory voiding urethrograms in even the youngest patients. This we have called the "P-O-mat." The principle employed in its design is similar to that used in automatic bell-ringing devices for the control of nocturnal enuresis. Here, however, the urinary stream activates a pair of electrodes which are connected to the x-ray apparatus. One distinguished pediatrician, on inspecting this apparatus, has aptly described previous attempts at orthograde urethrography in infancy as "null and void" (2).

DESCRIPTION OF APPARATUS

The part of the apparatus which is attached by adhesive tape over the infant's perineum consists of a rectangular "Perspex" (acrylic sheet) box, open at both ends (Fig. 1). Into the distal open end are incorporated two pieces of aluminum wire mesh, approximately 4 mm. apart. Each piece of wire mesh constitutes one terminal of the electrode pair. The proximal open end of the plastic box is contoured to fit over either the male or female perineum.

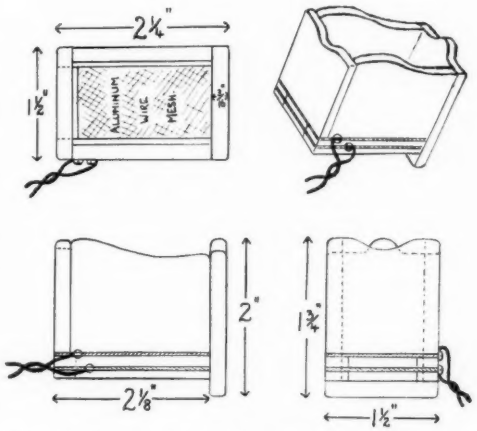


Fig. 1. Diagram of perineal electrode pair unit, made of "Perspex" (acrylic sheet).

The circuitry of the apparatus is shown in Figure 2, and its external appearance, together with the perineal electrode unit, in Figure 3.

The passage of urine across the electrodes completes the circuit, which causes the 5,000-ohm battery-fed relay to operate. This in turn energizes the 2-volt relay which closes the circuit to the 110-volt D.C. relay. (The 5,000-ohm and 2-volt relays are used to provide double isolation from the line voltage.)

The D.C. relay closes and remains energized until the 180-microfarad capacitor becomes charged; the 110-volt D.C. relay then opens. The time constant of this circuit (six seconds) allows contacts on

[1] From the Departments of Radiology and Medicine, The Montreal Children's Hospital, and the Departments of Radiology and Paediatrics, McGill University, Montreal. Presented before the Society of Pediatric Radiologists, Atlantic City, N. J., Sept. 26, 1960. Accepted for publication in October 1960.

[2] Picker X-ray Engineering Ltd., Montreal.

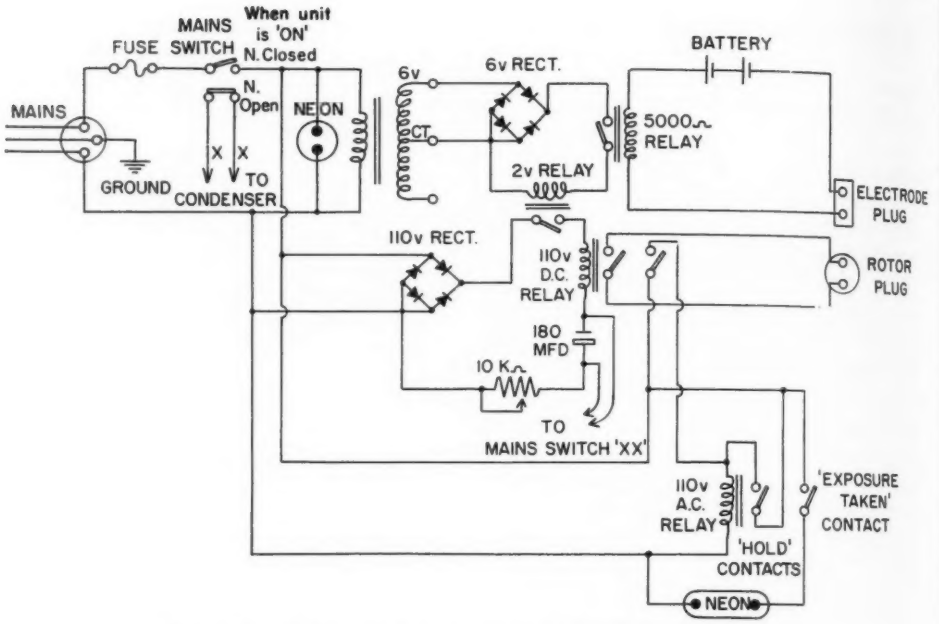


Fig. 2. Electrical circuit which provides double insulation for line voltage.

the D.C. relay to start the rotor on the x-ray tube and initiate an exposure. Following this, the rotor will be de-energized to prevent excessive wear of the x-ray tube bearings.

When the D.C. relay is energized, it also closes an A.C. relay which lights the "exposed" signal lamp to show that the unit has operated. This A.C. relay is provided with "hold-on" contacts to keep it energized until the unit is recycled.

Switching off the unit discharges the capacitor so that it will be ready for operation when next switched on. The time lapse between closing of the circuit and the resulting exposure is two and a half seconds.

METHOD OF USE

During intravenous pyelography in the infant, the filling and opacification of the bladder are observed during the first fifteen to thirty minutes. Whenever bladder density and size appear adequate, the child is placed in the left posterior oblique position, immobilized with sandbags and adhesive tape, and the perineal electrode pair unit is taped into position over the genitalia (Fig. 4). A feeding bottle is then given in order to pacify the infant and to promote early voiding, which usually occurs within five to twenty minutes.

When the infant voids, the opacification of the bladder and urethra is automatically recorded. Thereafter, the unit may be switched off when convenient, and if necessary the patient may be repositioned for further exposures of either the lower or the entire urinary tract.

DISCUSSION

Typical normal infantile voiding cystourethrograms in the male and female are reproduced in Figures 5 and 6, respectively. We have not used this procedure as an integral part of all excretory urography in infants, but rather prefer to select those patients in whom such an examination may be of diagnostic help. It is particularly useful in recognizing lower urinary tract obstruction. In addition, we believe that in many instances the procedure will help to identify vesico-ureteral incontinence with reflux. Such a case is

illustrated in Figure 7. Slight dilatation of the lower ureters during voiding was demonstrated. This finding prompted further investigation, including retrograde cystography, which showed a significant degree of vesico-ureteral reflux. Our hesitation to employ voiding urethrography in all infantile intravenous pyelograms is determined by the desire to protect the infant's gonads against unnecessary radiation.

The procedure has the advantage of not requiring the constant attendance of a qualified technician after the infant has been positioned on the cassette. An attendant, who wears a lead-rubber apron, stays in the room and watches the child until voiding occurs.

Immobilization of the infant is of utmost importance to the success of the method, and this can be achieved without undue distress to the patient. Inadequate immobilization has been a cause of failure in some of our cases. The other important cause of failure has been the occurrence of voiding prior to positioning for urethrography. However, with increasing experience the

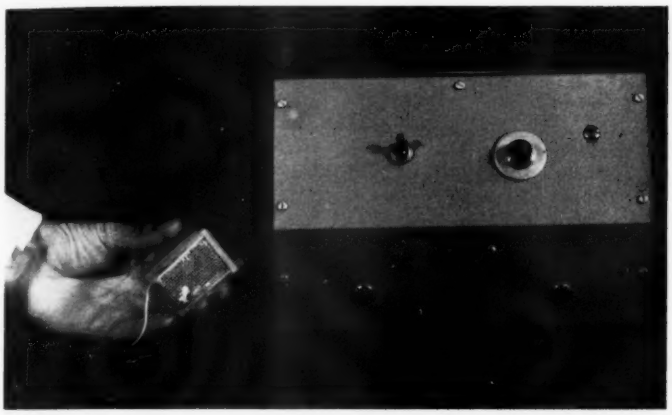


Fig. 3. External appearance of perineal unit and of electrical circuit housing. This circuit is plugged into the x-ray control panel through a special jack when required for excretory urography.

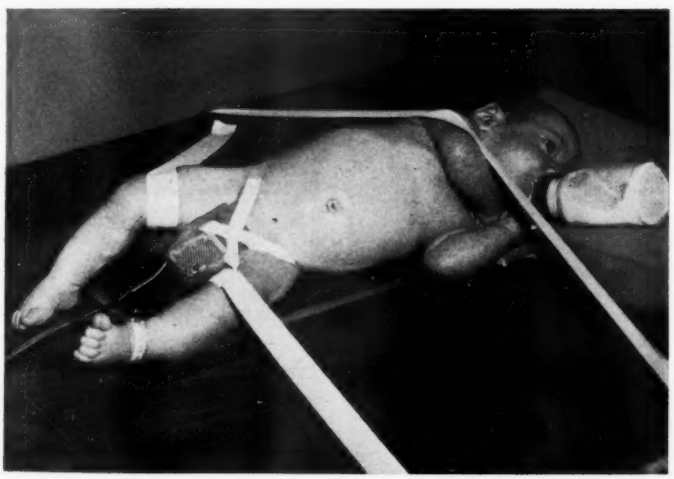


Fig. 4. Infant in position on cassette for left posterior oblique projection, immobilized by sandbags and adhesive tape.

Fig. 5. Normal excretory voiding urethrogram of ten-month-old male infant.

Fig. 6. Normal excretory voiding urethrogram of eleven-month-old female infant.

frequency of premature voiding can be considerably decreased. In fact, in some instances urethrography is still possible, despite early voiding in the course of intravenous pyelography, by waiting for micturition to occur a second time.

Fig. 7. Excretory voiding urethrogram of fifteen-day-old infant with urinary tract infection. The bladder and urethra appeared normal, but the lower ureters were a little wider during voiding than on the routine pyelogram. This led to retrograde cystography, which showed marked bilateral vesico-ureteral reflux.

The disadvantage of this procedure is that it does occupy a radiographic room for an additional five to thirty minutes, or occasionally even longer, after excretory pyelography is complete. However, since the only preparation necessary for the entire procedure is a saline enema, it can be scheduled at a convenient time.

The method, as described here, involves only a single additional exposure, during or following intravenous pyelography. It is

obvious, however, that it could be modified to utilize automatic film-changing apparatus or cinefluorography.

The physiology of the infantile urinary tract, which has for so long been felt to render intravenous pyelography difficult, does in fact favor successful cysto-urethrography. Due to small bladder capacity, the young infant voids frequently; this means that the waiting period for micturition is short. It also means that there is minimal dilution of the contrast medium in the bladder by retained urine. The bladder shadow is therefore relatively denser than in later life.

SUMMARY

An apparatus is described which permits voiding radiography of the infantile bladder and urethra during intravenous pyelography, without instrumentation of the lower urinary tract.

The Montreal Children's Hospital
2300 Tupper St.
Montreal 25, Quebec

REFERENCES

1. HOPE, J. W., JAMESON, P. J., AND MICHIE, A. J.: Voiding Urethrography: An Integral Part of Intravenous Urography. J. Pediatrics **56**: 768–773, June 1960.
2. MEDOVY, H.: Personal communication.

SUMMARIO IN INTERLINGUA

Un Dispositivo Automatic pro Urethrographia in Vacuation in Infantes e Juvenissimos

Es describite un apparatura que permitte radiographia durante le vacuation del vesica e urethra infantil durante pyelographia intravenose, sin le application de instrumentation al vias infero-urinari.

Le apparatura consiste de un rectangule cassa "Perspex" que es attachate per medio de bandas adhesive al perineo del infante. In le apertura al termino distal del cassa, duo pecias de rete de aluminium es incorporate. Iste pecias de rete representa cata un un del terminales de un par de electrodos que es connectite con le apparato de radios X. Quando vacuation occurre, le apparatura es activate per le fluxo urinari, e le opacification del vesica e del urethra es registrate automaticamente. Immobilisation adequate del infante es essential pro le successo del methodo.

SUMMARIO IN INTERLINGUA

Comparation Experimental de Acido Ortho-Iodohippuric con Iodopyracet in le Evalutation del Function Renal

(*Pagina 464*)

Post le injection de iodopyracet a I^{131} e acido iodohippuric a I^{131} in canes, contationes de scintillation monstrava le plus marcate differentia inter le duo compositos quando illos esseva usate pro renogrammas externe. Le acceptation hepatic de iodopyracet esseva plus grande.

Un studio del contationes renal monstrava (1) levemente plus curte periodos de medie secretion pro iodopyracet, (2) un significativemente plus curte periodo de medie excretion pro acido ortho-hippuric, (3) un significativemente plus curte periodo de medie clearance sanguinee pro iodopyracet, (4) un significativemente plus tarde culmine secretori pro acido ortho-hippuric, (5) nulle statisticamente significative differentia in le periodo de medie valor del apparition in le urina.

Le plus alte specificitate del molecula de acido ortho-iodohippuric pro excretion renal face de illo un melior medio pro le externe analyse del function renal e su curvas es plus facile a interpretar.

A Special Axial Rotation Table for Pneumoencephalography[1]

JUAN M. TAVERAS, M.D.

ALL OF THOSE who have been involved in doing pneumoencephalography and ventriculography, particularly in the anesthetized or unco-operative obese patient, are aware of the great difficulties encountered in turning the patient and in obtaining straight films. The need of a special table for this purpose is frequently acknowledged, but none has been available on the market.

After some thought it was decided to build a table capable of turning 360° with the patient strapped in place. The rotating mechanism is situated at one end of the table, supported by a hydraulic pedestal. This permits lowering and raising of the table to a desired level before the patient is placed on it.

The method of suspending the patient presented certain problems. It was decided simply to use two padded side boards in addition to a straight padded board to be placed on the ventral surface if the patient is to be examined initially in the supine position, or on the back, if he must first be placed prone. The padded side boards can be swung out of the way or removed altogether to facilitate the placement and removal of the patient (Fig. 1). They also prevent his rolling to the side when turned 90° in either direction.

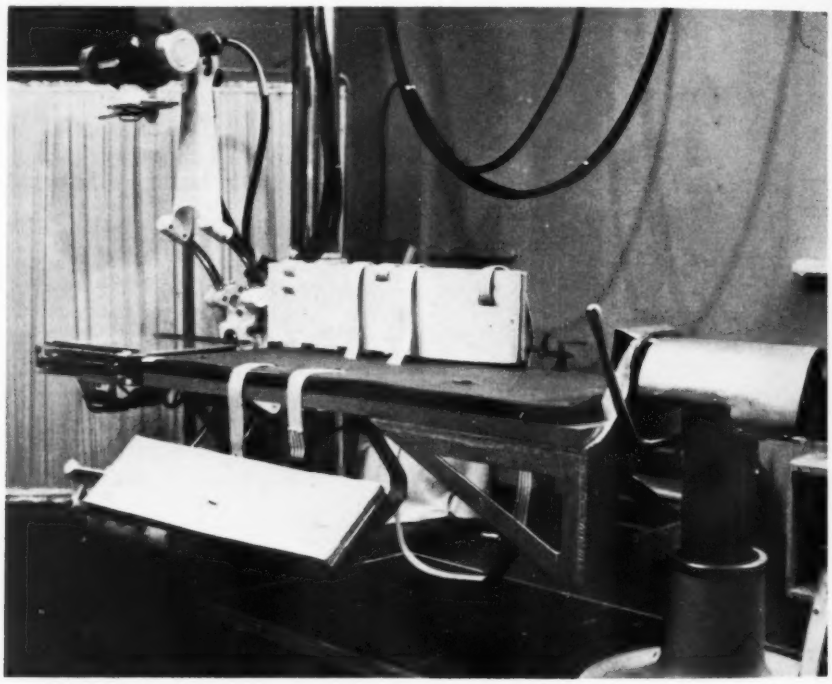


Fig. 1. Axial rotation table for pneumoencephalography; side board swung out of place.

The patient is secured in place by straps from the central portion of the table and from the side boards. Extra padding to adjust to the individual shape and size is usually unnecessary, because the side

[1] From the Department of Radiology, Neurological Institute, Columbia Presbyterian Medical Center, New York, N. Y. Accepted for publication in August 1960.

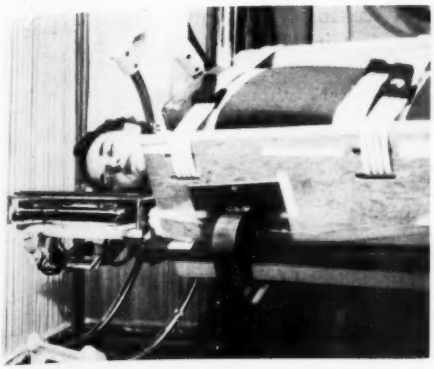


Fig. 2. Patient in position for examination.

boards are adjustable to the patient's width and the top padded board is always in contact with him. Rarely, with particularly unco-operative patients is it necessary to add straps over the shoulders so that they cannot move cephalad. Broad bands of adhesive tape can be employed for this purpose.

The head is free and may be supported by a board which can be pulled out from the end of the table. When radiographs are to be made, this board is pushed in and the head is placed on the radiographic apparatus (Fig. 2). A Schönander or a Franklin head unit can be used for this purpose. We have successfully employed a simple bantam Bucky mounted on a small pedestal which can be wheeled around easily. If intravenous fluids are required during the examination, it is easy to leave the arm outside, tied to the side board with adhesive or with a strap.

The apparatus greatly facilitates the changing of the patient's position while an endotracheal tube is in place, since the head does not have to be turned to obtain the various films required in frontal and lateral projections. In addition, the special stretcher is mounted on wheels and may be taken to the operating room, so that it is necessary to transfer the patient only once.

The device has been found to be useful when it is desired to fill certain portions of the ventricular system such as the temporal horns because of the ease with which

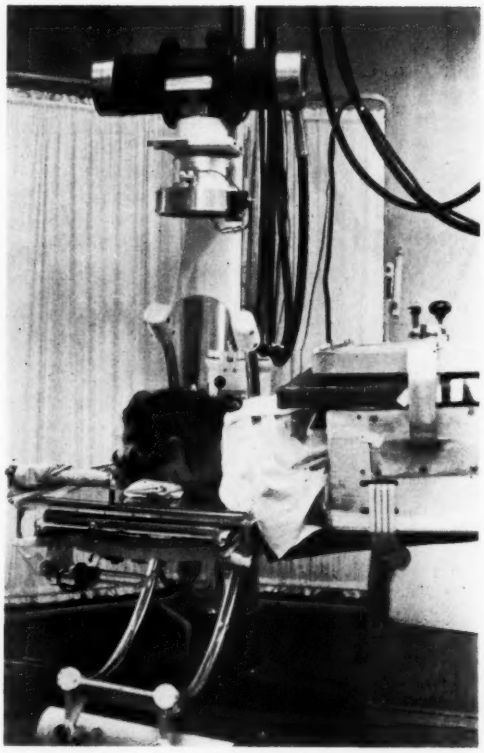


Fig. 3. Table turned for prone film.

the patient may be turned into the various positions.

COMMENTS

The table described has been in use in the Department of Radiology at the Neurological Institute (New York) for about a year and has been of great help in handling difficult cases. All patients are placed on it for the recumbent series of films. For lateral views it is not even necessary to strap the patient; a slight turn of the table is sufficient (Fig. 2). For this reason it can be of great help in cerebral angiography in departments where facilities for taking lateral serial films with the horizontal x-ray beam do not exist. The needle may be placed in position first; the patient is then turned just enough that a straight lateral view may be obtained with only a slight turn of the head. The table has not been used for this purpose at the Neurological Institute.

The patient may be initially strapped either in the supine or in the prone position, more commonly in the former, because the anteroposterior and "brow-up" lateral views are usually made first. For taking the prone films the table is simply turned 180° (Fig. 3).

Neurological Institute
622 W. 168th Street
New York 32, N. Y.

SUMMARIO IN INTERLINGUA

Un Tabula Special de Rotation Axial pro le Pneumoencephalographia

Es describite un tabula que rende plus facile le effectuation de pneumoencephalographia e ventriculographia in anesthesiate o non-cooperative patientes. Illo permitte un rotation del patiente per 360°—con le patiente ligate in sito fixe. Sed illo non interfere in le uso del tubo endotracheal o in le administration de liquidos intravenose. Le lectiera es montate super rotas e pote esser rolate al sala de operationes, de maniera que le patiente debe esser transferite non plus que un sol vice.

Equipment Aids in Intravenous Pyelography

W. C. SMULLEN, M.D., J. W. LITTLE, JR., M.D., and F. A. WINTERS, M.D.

IN RECENT articles by Hildreth, Pendergrass, Tondreau, and Ritchie (1, 2), a comprehensive evaluation of the reactions associated with intravenous urography has been given, along with methods of prevention and therapy. We feel that a simple and practical technic for intravenous administration of urographic media may be of general interest. Equipment includes;

1. Anesthesia arm stand
2. Opaque material: diatrizoate sodium (Hypaque)
3. Sterile normal saline, 150 c.c. ($0.66)
4. Disposable plastic infusion tubing, Baxter-41 ($0.40)
5. Disposable needles ($0.10)
6. Venotube 20 ($0.28)
7. Syringe, 20 c.c.

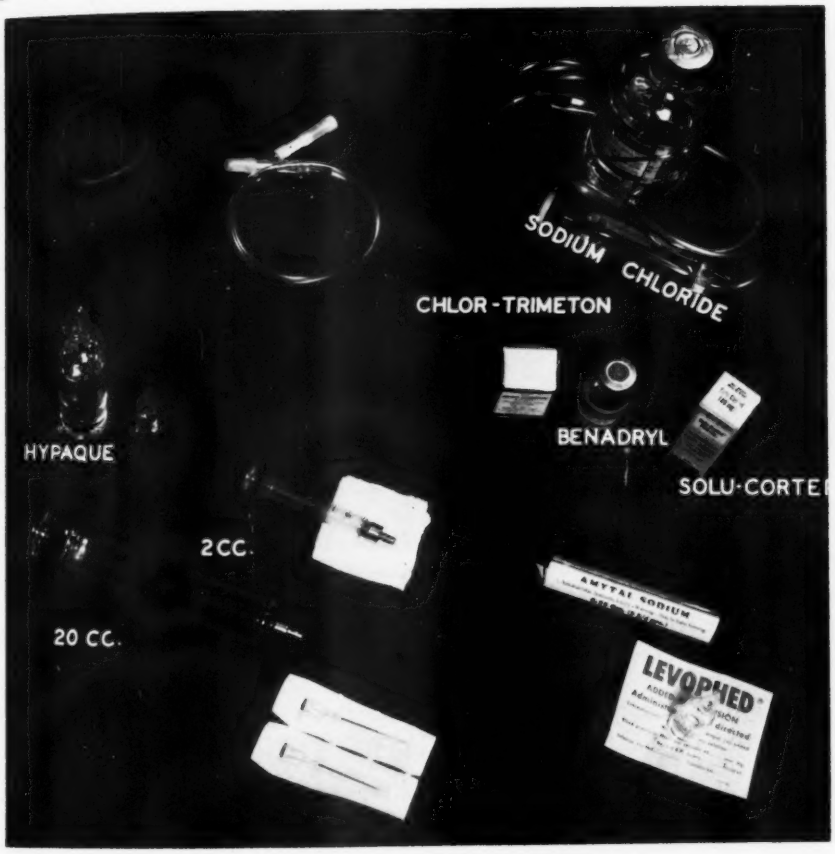


Fig. 1. Equipment for intravenous pyelography.

8. Medication and equipment in stand drawer:
   (a) Epinephrine HCl, 1:1000, or Neophed
   (b) Antihistamine (diphenhydramine HCl, chlorprophenpyridamine maleate) in sterile solution for injection

[1] From the Department of Radiology, St. Mary's Hospital, Decatur, Ill. Accepted for publication in September 1960.

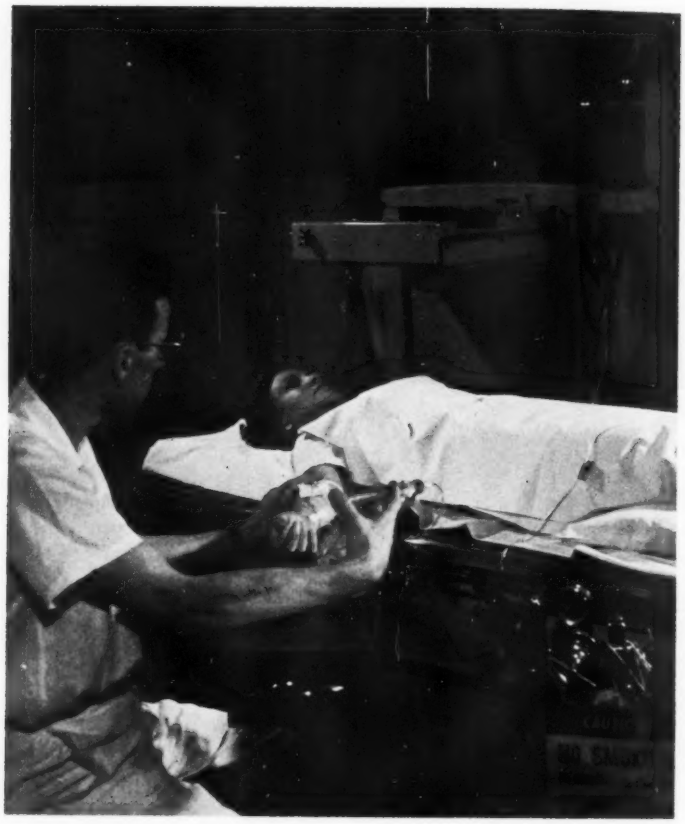


Fig. 2. The patient in position for the examination.

(c) Phenylephrine HCl (0.5 mg.)
(d) Levarterenol bitartrate (Levophed)
(e) Hydrocortisone 100 mg./c.c.
(f) Oral airway
(g) Syringe (2 c.c.) and disposable needles
(h) Spare tourniquet

9. Oxygen and blood-pressure apparatus in room

TECHNIC

Upon arrival in the Radiology Department the patient is questioned regarding any history of allergy, including hay fever, asthma, urticaria, and any known reaction to medication. If the history is negative, an abdominal scout film is obtained and this is viewed wet by the radiologist. If there is no indication of poor preparation or other factors which would preclude adequate studies, the examination is continued. The patient is made as comfortable as possible on the examining table. A radiolucent mattress is used, and a pillow is placed beneath the knees.

The patient's arm is anchored to the anesthesia stand in a comfortable, supine position (Fig. 2). A needle, connected to a 150-c.c. vial of sterile normal saline by a standard intravenous solution administration set is introduced into an accessible vein, preferably antecubital, and a slow infusion is begun. A test dose of 1.0 c.c. of the opaque material is injected into the rubber coupling of the intravenous set. If there is no evidence of reaction after an interval of ten minutes, the radiologist is called to administer the full dose of the medium. He again questions the patient

concerning any possible allergic history. If the reply is satisfactory, 20 c.c. of the opaque medium is injected into the rubber coupling by connecting the 20-c.c. syringe to a sterile disposable needle with a 20-inch length of disposable plastic tubing (Venotube 20). The syringe is supported by the clamp on the anesthesia stand (Fig. 3).

SUMMARY

A simple, practical, and inexpensive method of administering opaque media for pyelography is presented, and the advantages of this technic are described. They are as follows:

1. Venospasm is decreased as a result of slight dilution of opaque material by normal saline.
2. Only one venipuncture is necessary for both the test dose and diagnostic dose of opaque solution.
3. There is no loss of time in performing venipuncture, or attempting to find an adequate vein, should any serious side-effects occur.
4. The incidence of minor side-effects is decreased, as observed over a period of five years.
5. Medication and equipment are readily available in the drawer of the anesthesia stand, in event of emergency.
6. The small amount of normal saline aids in concentration of the medium.
7. The procedure is convenient for both patient and radiologist.
8. The added cost of equipment is slight when compared with the above advantages ($1.44).

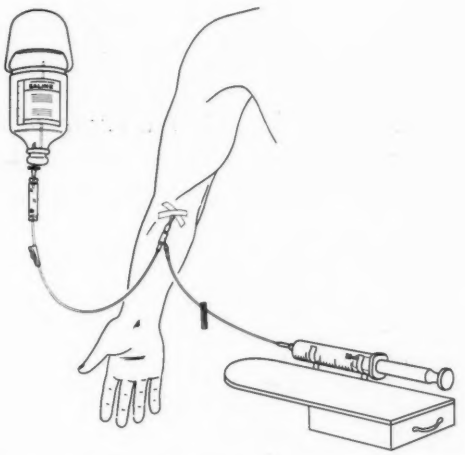


Fig. 3. Arrangement of saline infusion apparatus and syringe for injection of the medium.

NOTE: Photographs courtesy of the Illustration Department, Decatur and Macon County Hospital, Decatur, Ill.

St. Mary's Hospital
Decatur, Ill.

REFERENCES

1. HILDRETH, E. A., PENDERGRASS, H. P., TONDREAU, R. L., AND RITCHIE, D. J.: Reactions Associated with Intravenous Urography: Discussion of Mechanisms and Therapy. Radiology **74**: 246–254, February 1960.

2. PENDERGRASS, H. P., TONDREAU, R. L., PENDERGRASS, E. P., RITCHIE, D. J., HILDRETH, E. A., AND ASKOVITZ, S. I.: Reactions Associated with Intravenous Urography: Historical and Statistical Review. Radiology **71**: 1–12, July 1958.

SUMMARIO IN INTERLINGUA

Adjutas de Apparatura in Pyelographia Intravenose

Es reportate un simple, practic, e incostose methodo pro le administration intravenose de substantias de contrasto pro le objectivos del pyelographia.

Con le patiente in positura super le tabula de examine, le bracio es ancorate al supporto de anesthesia in un confortabile position supin. Un agulia, connectite a un flasco de sterile solution salin normal via un dispositivo standard pro le administration intravenose de solutiones, es introducite in un vena accessibile, preferibilemente le vena antecubital, e un lente infusion es comenciate. Un dose experimental de 1,0 cm^3 del substantia opac es injicite in le copulage de cauchu del dispositivo intravenose. Si nulle reaction es manifeste, 20 cm^3 del substantia es injicite in le copulage de cauchu per connecter un syringa de 20 cm^3 a un agulia a uso unic con un tubo plastic a uso unic de 20 pollices de longor (Venotube 20). Le syringa es supportate per le crampa al supporto de anesthesia.

WORK IN PROGRESS

Absorbed Dose in the Thoracic Vertebrae in Chest Roentgenography[1]

R. WILSON, B.Sc.,[2] and J. A. CARRUTHERS, Ph.D.[3]

The dose received by the active bone marrow during certain diagnostic procedures is of considerable interest in this present era of ever increasing exposure of the general population to ionising radiation. The dose to the hemopoietic organs has received considerable attention. Previous measurements of dose to bone marrow have been made with small-volume condenser chambers especially developed to have a uniform energy response in the region of interest (1, 2). The disadvantages of using an ionisation chamber for measuring energy absorbed in biological sites are: (*a*) disturbance of the biological medium by the introduction of the air equivalent and air-filled chamber, (*b*) the difficulty of achieving satisfactory energy response to take account of the low-energy degraded radiation at the site, and (*c*) the considerable polar dependence of most ionisation chambers. This work describes the measurement of absorbed dose in the 7th and 8th thoracic vertebrae in a human phantom at x-ray energies, using a sensitive small volume chemical dosimeter.

The *dosimetric system*, a 10^{-4} molar solution of calcium benzoate in water, has been previously described (3–5). On irradiation, salicylic acid is produced and there is a linear relationship between absorbed dose and salicylic acid concentration. The analysis for salicylic acid is carried out on an Aminco Bowman spectrophotofluorometer. There is no energy dependence from 50 kvp unfiltered x-radiation (h.v.l. 0.1 mm. Al) to 150 kvp with 0.5 mm. Cu filtration (h.v.l. = 0.7 mm. Cu). The irradiation cells, 4 cm. in length and approximately 2.2 mm. in diameter, contained slightly more than 0.1 ml. of solution.

The *phantom* was of mix D wax, elliptical in cross section, with sagittal and lateral dimensions of 23 and 30.5 cm., respectively. It contained all bones lying between T-1 and L-2. All bones were wax filled. A cork and wax mixture with a density of 0.3 gm./ml. was used to simulate lung tissue.

Exposure Conditions: The dosimeter cells were inserted into a close-fitting cavity in T-7 and T-8 The interfaces of these two vertebrae were ground slightly to obtain a flat fit. The phantom was irradiated in the following two fields:

(*a*) 80 kvcp; 2 mm. Al added filtration; h.v.l. 2.5 mm. Al; T. F. D. 72 inches. Exposure 20 ma for two hours. The field at the film position was 21 × 19 inches. This represents a large postero-anterior chest film.

(*b*) 90 kvcp; 2.5 mm. Al added filtration; h.v.l. 2.9 mm. Al; T. F. D. 50 inches. Exposure 20 ma for one hour. The field size at the film position was 20 × 17 inches. This represents a miniature postero-anterior chest film.

In both these exposures the x-ray machine output was monitored by an extremely thin-walled (.001 inch) Aquadag-coated Mylar parallel plate chamber for the duration of the exposure.

Results: The measured values of energy absorbed/mas in T-7 and T-8 are 0.83 and 1.9 millirads for the 80 kvcp and 90 kvcp diagnostic fields, respectively.

DISCUSSION

The procedures in the present measurements and those reported by other workers (1, 2) are not identical, but an attempt has been made to compare results. In the large film exposure Garrett *et al.* (1) used 90 kvp and the field diameter was 80 cm. The fluoroscopic field size and energising voltage were similar to those in the present work but the T. F. D. was 40 inches. Conversion to rads for the ionisation chamber measurements was done, using 0.9 rads/roentgen, and for the fluoroscopic unit the ionisation chamber measurement was converted to a T. F. D. of 50 inches. The results of these calculations give energy absorbed in the thoracic vertebrae as 1.56 and 4.0 millirads/mas compared to 0.83 and 1.9 millirads/mas, respectively, for the chemical dosimeter measurements reported here.

Although differences in exposure conditions and phantom construction could account for part of this lack of agreement, perhaps the most significant difference is to be found in the dosimeters themselves. The chemical dosimeters are considerably smaller, are of higher density, and are almost entirely tissue-equivalent.

It is planned to undertake further measurements of energy absorbed in diagnostic procedures, in other bones of interest, such as ribs and sternum.

REFERENCES

1. GARRETT, R., TAMUSZ, O., MEURK, M. L., LAUGHLIN, J. S., AND SHERMAN, R. S.: Dose Measurement Technics for Diagnostic Procedures. Radiology **71**: 216–221, August 1958.

2. LAUGHLIN, J. S., MEURK, M. L., PULLMAN, I., AND SHERMAN, R. S.: Bone, Skin, and Gonadal Doses in Routine Diagnostic Procedures. Am. J. Roentgenol. **78**: 961–982, December 1957.

3. ARMSTRONG, W. A., AND GRANT, D. W.: A Highly Sensitive Chemical Dosimeter for Ionizing Radiation. Nature **182**: 747, Sept. 13, 1958.

4. ARMSTRONG, W. A., AND GRANT, D. W.: The Aqueous Benzoate System as a Sensitive Dosimeter for Ionizing Radiations. Canad. J. Chem. **38**: 845–850, 1960.

5. WILSON, R., AND CARRUTHERS, J. A. Measure-

ment of Bone Marrow Dose in a Human Phantom for Co^{60} Gamma Rays and Low Energy X-rays. To be published.

[1] Issued from Defence Research Chemical Laboratories, Ottawa, Ont., as DRCL Report No. 342.
[2] Present address: Radiation Protection Staff, Ontario Hydroelectric Commission.
[3] Present address: Department of Physics, McGill University, Montreal, P. Q.

Solid-State and Proportional Beta Detectors for Use in Vivo[1]

C. V. ROBINSON, Ph.D.

For various diagnostic procedures with radioisotopes, small β-detectors used *in vivo* have proved to be of value. Geiger-Müller, proportional, and scintillation counters have all been used. Solid-state detectors give promise of being superior for certain applications. Work in progress on special proportional counters and some preliminary measurements on solid-state detectors are reported in this paper.

Melanomas of the eye have been shown to take up P^{32} preferentially following intravenous administration. Measurement of the β radiation from the affected area and comparison with a control area give a ratio which has a useful degree of correlation with the diagnosis of cancer. Geiger-Müller counters suitable for exploring the anterior portion of the eye are commercially available. Since about half the melanomas occur posteriorly, a suitably shaped counter is needed to explore the back of the eye.

A special, proportional detector of suitable shape and sensitivity for posterior eye tumor localization has been built and is now in use. This counter has a thin, bent section to fit the eyeball over 120° of arc, with a sensitive aperture 5 mm. in diameter, covered with a thin metal window inside the arc near its extremity. It is of "all-metal" construction and may be steam autoclaved, together with its cable.

Since the proportional tube has proved difficult to construct, thought has been given to the possible use of solid-state detectors for this purpose. The necessary flat shape and small size are natural to this type of detector, exclusive of its mounting. The problems of mounting the detector into a properly shaped, sterilizable holder and of providing circuitry suitable for routine use would have to be solved. Preliminary laboratory measurements with a silicon junction diode[2] demonstrate that hard β rays may be detected with about the same efficiency and background count as would be obtainable with an equivalent Geiger-Müller or proportional counter. With a thin source of P^{32} on a brass backing, and with the recommended bias voltage, the average pulse size corresponded to 250 kev of energy absorbed in the sensitive layer of the diode.

[1] From the New England Center Hospital, Boston 11, Mass.
[2] RCA Victor Co. Ltd., Montreal, Canada. Type C, 5 mm. diameter sensitive aperture.

EDITORIAL

Some Logistics of The Radiological Society of North America, with Thoughts About the Future[1]

In 1954, Dr. Eugene P. Pendergrass entitled his Presidential Address before the Radiological Society of North America "Looking Backward." He recalled the early days, when the Society was formed from its progenitor, the Western Roentgen Society. The Western Roentgen Society had been organized in St. Louis, late in 1915, because of an ever-increasing interest among physicians in the Mid-West in the new diagnostic tool, the x-ray. Most of these doctors could not afford the time and expense involved in traveling to the East to attend the early scientific sessions of the American Roentgen Ray Society, which came into existence in 1900. Also, the American Roentgen Ray Society had developed into an organization of fully trained specialists. Membership in it was not easily acquired, since applicants were expected to have done some valuable original work before their election. There was a firm belief, held by the founders of the Western Roentgen Society, that there should be a place in organized radiology in which young men might be encouraged to develop.

In 1918, during the presidency of Dr. Benjamin H. Orndoff, when the new society was only three years old, it already had 472 members in 38 states. It was, obviously, no longer a "Western" society. The officers and other leading members became convinced that the organization could serve the younger radiologists of North America better by expanding into a national body. Accordingly, at an executive session of the Fifth Annual Convention of the Western Roentgen Society on Dec. 10, 1915, at the Sherman Hotel in Chicago, the name of the organization was changed to "The Radiological Society of North America." At the same time, the name of the Society's official publication was changed to *Journal of Radiology*.

In his Presidential Address at that meeting, Dr. Oliver H. McCandless said: "We should welcome the advent of co-workers and the utilization of different forms of radiant energy in the specialties of medicine, for it is to these men indulging in these specialties that we must look for the diversified use of radiant energy." The attitudes he expressed are embodied in Article II of the Bylaws of the Society which state its objects. Section V reads: . . . "to create a closer fellowship among radiologists and closer co-operation between radiology and members of other branches of medicine and the allied sciences."

In his talk, Dr. Pendergrass recounted some of the vexing problems of the young, sturdy, and rapidly growing Society. I am sure all of you would enjoy reading the story in full, as it is printed in RADIOLOGY for February 1956.

Today, I should like to take account of the present status and cast an inquiring glance into the future of the Radiological Society of North America. In 1918 there were 472 members and in 1921 approximately 700; in 1933 there were 1,111, in 1950 there were 2,109, and in 1954 membership had increased to 2,535. In 1960, Acting Secretary Dr. Robert P. Barden reports 3,409 members, 186 persons having joined last year. This year, 324 new applications for membership were proc-

[1] Presidential Address delivered before the Radiological Society of North America, at the Forty-sixth Annual Meeting, Cincinnati, Ohio, Dec. 5, 1960.

essed and sent to the Board of Censors for recommendations.

Dr. Edwin C. Ernst recalls that, at the first Mid-Annual meeting of the Western Roentgen Society, one of the scientific sessions was attended by only 12 doctors and technicians. Data for attendance at the early meetings are not readily available. In 1950, the total attendance was 2,090, in 1955 it was 2,620, and in 1959 it was 3,127. At several meetings, the guests outnumbered the members. At the 1953 meeting, 358 residents were tallied in a total of 1,474 professional people. As you know, residents are welcome, free of charge.

The meeting grows in size like a snowball rolling downhill. This is probably due, in some measure, to the *esprit de corps* of the Society, which caused the late Dr. Arthur W. Erskine to say of it: "It is strong because of its democracy, its unity and solidarity, and the deep feeling, amounting almost to affection, its members have for the organization they have labored to build and maintain. Those who first attend one of its meetings are impressed by the spirit of friendliness that prevails, and they observe that 'everybody seems to have a good time.' Surely, the hopes, the ideals, and the aspirations of its founders have been satisfactorily and adequately consummated."

Another cause for the continued increase in size of our meeting is the availability of key persons at that time. This makes it possible for smaller organizations, or committees of allied groups, to meet before, during, or immediately after the larger meeting, saving both time and expense.

During the time of this year's meeting, there will be eleven meetings of Commissions or Committees of the American College of Radiology, one of them in conjunction with the newly formed American Association of Physicists in Medicine. This joint session will discuss the physics instruction program for residents in radiology. Also meeting all day Saturday and part of Sunday will be the Educators in Veterinary Radiologic Science. The program directors of radiological training programs of the National Cancer Institute have also found this a convenient time to gather. In addition, four groups of radiologists will get together to honor their former teachers and to hobnob a bit. Four large manufacturers of x-ray equipment and supplies have cleared through the Society to hold staff meetings. The American Club of Therapeutic Radiologists and the Eastern Theater of Operations Radiologists have scheduled dinners and meetings. The Gastube Gang will meet.

Scattered in, around, and between these activities will be various activities of the Society itself, 3 or 4 long sessions of the Board of Directors, one long session of the Board of Censors, the Councilors Dinner, a meeting of the Program Committee, a meeting of the Physics Committee, a luncheon of the abstractors who do such a wonderful job for RADIOLOGY, and a joint meeting of the x-ray section committee of NEMA (National Electrical Manufacturers Association), with the Radiologists-Manufacturers Committee of the Society.

All of this is just the spice sprinkled over the regular menu, consisting of 63 Refresher Courses of ninety minutes each, 88 essays of fifteen or twenty minutes each and 35 Works-in-Progress papers of ten minutes each. There are also the important Business Sessions of the Society and, of course, some strictly social gatherings.

The schedule given above and the large number of registrants tax the facilities of all but a few hotels. Even some of those have undesirable features, so that, in recent years, only the Palmer House in Chicago has fairly adequately fulfilled our demands. The possibility of utilizing a convention hall had been discussed repeatedly, and in 1949 the Society headquarters were in the Statler Hotel, Cleveland, while the sessions themselves were held in the Public Auditorium. After bracing against Cleveland's lakefront winds and feeling the bite of cold and snow, most

of the members were glad to get back to the coziness of a hotel meeting.

Recent developments in the hotel business may come to our aid. Many of the large hotels are rebuilding and expanding their public rooms and exhibit areas and, in a few years, we may have a choice of satisfactory hotels in several cities.

There is another problem relative to the meeting of the Radiological Society of North America which deserves discussion. I refer to the time of the meeting. Traditionally, it has been held in late November or early December. This scheduling, so close to the meeting of the American Roentgen Ray Society, which is usually held late in September or early in October, has been the target of frequent complaints from several sources. Prominent among these have been the manufacturers of radiological equipment. They find it difficult to prepare anything new or different for the second meeting. The close scheduling of some recent years meant that they were hardly settled, upon returning from one meeting, before they had to leave for the next one.

I should like to add my voice to those who believe that the meetings of the two major radiological societies should be spaced farther apart. My problem arose in the work of the Program Committee which, in this Society, is headed by the President. Not until I saw the preliminary program arranged by Dr. Harold G. Reineke's Program Committee for the September 1960 meeting of the American Roentgen Ray Society did I know whether or not there would be a duplication of material presented. Fortunately, there was only one identical title. Further separation of the dates of the two meetings would relieve this difficulty.

Some years ago, when solo radiological practice was more prevalent and many radiologists tried to attend both meetings, there were also numerous complaints from radiologists. Today, with group practice growing in favor, many men alternate with their partners in attendance at the meetings of the two major societies. This makes some duplication less objectionable, but it seems undesirable, in view of the wealth of material available. The time of the meeting is still unpopular. Our frequent gatherings in Chicago have certainly not been in the most salubrious climate.

The Chicago location is the most favorable from the standpoint of cost and attendance. I am sure, however, that the Board of Directors will take the meeting wherever the members wish, providing the cost is not excessive for the income of the Society (dues can always be raised!) and a good attendance is assured.

This year, the members of the Society are being asked to vote in favor of a revision of the Bylaws which would allow the Board of Directors to make commitments up to five years for accommodations for the meetings of the Society. The present Bylaws limit such commitments to two years. This has been a restraining regulation, and its effects were avoided only because of the friendship of Dr. Donald S. Childs with various hotel managers, who would accept his word and "protect" a verbal commitment, until it could be finalized in conformity with the present Bylaws.

Those who are members of other organizations no doubt are impressed by the fact that the dues of the Radiological Society of North America have so long remained at $15 per year. There is now little reason for a radiologist to remain outside the Radiological Society of North America. The dues of $15 per year entitle him to attendance at all sessions of the annual meeting, including the business sessions, the refresher courses, scientific programs, technical and scientific exhibits, and also provide for his receipt of the monthly journal, RADIOLOGY. The guest, although paying $25, does not receive RADIOLOGY and cannot attend the business sessions.

The dues of many other societies have increased greatly, especially in the past ten years. Our good experience is due, in great part, to the wise handling of the Society's funds by the late Dr. Donald S.

Childs. May our new Treasurer be similarly capable and successful. The task may be more difficult in the future, if the forces of inflation develop further.

Now I should like to mention another problem which I think radiology, as a profession, is handling poorly. I refer to the preservation of the mementos of our specialty's early days. These mementos should be gathered together and preserved. They consist not only of items of physical equipment, old radiographs, and old textbooks, but also of the precious facts that lie filed away in the minds of some of our older members.

We have had forty-five Presidents in the forty-six years of our existence, our first President, Dr. Fred S. O'Hara, of Springfield, Ill., having served for two years. Of these, twenty-seven have passed on, taking with them into oblivious silence many facts which would be of great interest to us and to those who will follow us. Those who remain should be urged to record, even if only in a reminiscent fashion, some of the history of their times. A compilation of such material would constitute an important and valuable work.

A consideration of economy and of the urgent need for a place where some of the history of radiology could be gathered together and preserved caused the Chicago Roentgen Society to take action three years ago. It formulated a resolution, which I give you in part: ". . . that a headquarters for radiology be established—to house the American Roentgen Ray Society, the American Radium Society, the Radiological Society of North America, the American College of Radiology, and the American Board of Radiology. Modern business methods would seem to dictate operational activity under one roof, and such a development would allow for the establishment of quarters suitable for the housing of a Museum of Radiology—Past and/or Contemporary. The purpose is not to merge the organizations but merely to provide a central office with greater economy, efficiency, and collaboration." Unfortunately, the resolution was not conducive to action by any of the groups to which it was directed.

I mention this in an effort to stimulate some interest in the situation. Meanwhile, hope for a positive approach comes from another source. The Board of Directors of the American College of Radiology Foundation, a nonprofit, tax-exempt organization, recently adopted a program presented by its Treasurer, Dr. Fay H. Squire. This provides, in part, that the funds of the Foundation may be invested to provide a "Home" for radiology. In view of the good experience of the American College of Radiology group life-insurance program, which is the main source of revenue for the Foundation, the days of dreaming may soon end and the days of reality may be near. Perhaps then we can be in compliance with Section IV of Article II of our Bylaws which, under the title Objects, says " . . . to maintain a library and museum."

The experience of others in these matters makes me hope for the future of the project. When I attended the dedication of a new building of the Deutsches Roentgen Museum at Remscheid-Lennep in West Germany last July, as a United States delegate representing the Radiological Society of North America, I learned that that museum had been planned since 1907 but was not actually founded until 1930. So we are not far off the pace.

In summation, then, the Radiological Society of North America is a vigorous, growing organization, friendly to the neophyte radiologist and to members of allied disciplines. It has had, and will continue to have, growing pains. Its meeting time, suitable and convenient for its founders, is no longer convenient for many and should be changed. Consideration should be given to cooperation with other radiological societies in the establishment of a museum of radiological history, possibly in a building in which the clerical mechanics of the various radiological organizations could be combined, a true "Home" for radiology.

THEODORE J. WACHOWSKI, M.D.

IN MEMORIAM

CHARLES HUNTER HEACOCK, M.D.

1888–1960

In the passing of Dr. Charles Hunter Heacock, of Memphis, Tenn., at the age of seventy-two, radiology lost one of its most distinguished and beloved practitioners. He died suddenly, on Dec. 30, 1960, at the home of his daughter, Mrs. Robert (Mary Ann) Kulp, in Ardmore, Penna., where he was spending the holidays. He had suffered a series of heart attacks about fourteen months previously but had sufficiently recovered to have returned to work.

Charles Heacock was born at Turbotville, Penna., and was graduated from Bucknell College, and from the University of Pennsylvania Medical School with honors, class of 1917. Immediately following graduation, he answered our Medical Corps call to join the British Army and served in France and England for the duration of the war. He was in the front line trenches at Ypres. He was discharged as Captain and returned to America to begin his internship at the Post-Graduate Hospital, University of Pennsylvania.

Dr. Heacock's career in radiology began in 1920 with his appointment as a Fellow at the Mayo Foundation. Upon completion of his radiological

training at the Mayo Clinic in 1923, he practiced a short time in Pueblo, Colo. In 1925 he moved to Memphis, Tenn., to become radiologist at the Polyclinic. This clinic was dissolved in 1932, and he accepted the position of radiologist at St. Joseph Hospital, at the same time maintaining a private office for the practice of radiology.

His teaching experience began in 1911–13, when he was named Head of the Department of Science at Broaddus Institute, Philippi, West Virginia. He was appointed to the Staff of the Department of Radiology, University of Tennessee, in 1931, and Chairman of the Department in 1938. At the age of seventy he became Professor Emeritus.

Dr. Heacock enjoyed the respect and friendship of his medical colleagues. He was elected President of the Staff of St. Joseph Hospital in 1941 and President of the Memphis and Shelby County Medical Society in 1946. He was Chairman of the Executive Council of the American Roentgen Ray Society in 1943–44; First Vice-President of the Radiological Society of North America in 1948. He served as President of the Memphis Chapter of the American Cancer Society in 1956–58.

Dr. Heacock was prominent in church, civic, and social affairs. He was Chairman of the Board of Deacons of the First Baptist Church in Memphis for many years. He was an ardent golfer and could be seen on the golf links of the Chickasaw Country Club every Monday and Thursday afternoon, weather permitting.

He is survived by his daughter, Mrs. Robert Kulp of Ardmore, Penna., and four grandchildren.

Dr. Heacock will be remembered as an outstanding citizen, churchman, and physician, and will be greatly missed by his patients and many friends.

J. CASH KING, M.D.

JOHN EVANS HEATLEY, M.D

1887–1961

Dr. John Evans Heatley of Oklahoma City, Okla., a member emeritus of the Radiological Society of North America, died on Jan. 20, 1961. Dr. Heatley was born in Hiawatha, Kans., and received his M.D. from the University Medical College of Kansas City, Missouri, in 1911. He became affiliated with the Medical School of Oklahoma University in 1916. He was made Professor of Radiology in 1932 and was departmental chairman from 1943 to 1948. He had been Professor Emeritus of Diagnostic Radiology since 1949. He was named a life member of the American College of Physicians in 1927 and was a Fellow of the American College of Radiology.

AMERICAN ASSOCIATION OF PHYSICISTS IN MEDICINE

The American Association of Physicists in Medicine adopted its first formal constitution and elected its first set of permanent officers under the new structure at its Annual Meeting in Cincinnati in December. Membership is open only to persons who are primarily and professionally engaged in the application of physics to medicine and biology in medical installations or research or educational institutions. The objectives of the Association are to encourage interest and training and to prepare and disseminate technical information in medical physics and related fields, to secure and maintain high professional standards for physicists in medicine and biology, and to serve and represent their professional interests.

There are 132 charter members of the Association. Officers for 1961 are Warren K. Sinclair, Ph.D., Argonne National Laboratory, Argonne, Ill., President; John Hale, Ph.D., University of Pennsylvania Hospital, Philadelphia, Penna., Vice-President; Charles S. Simons, Ph.D., University of Michigan Hospital, Ann Arbor, Mich., Secretary-Treasurer.

Inquiries about membership and activities of the Association may be directed to Dr. Simons at the Radiation Therapy Center, Ann Arbor, Mich.

SOCIETY OF NUCLEAR MEDICINE SOUTHWESTERN CHAPTER

The Southwestern Chapter of the Society of Nuclear Medicine will hold its annual meeting April 6–9, 1961, at the Ramada Inn, Oklahoma City, Okla. Peter E. Russo, M.D., 1200 North Walker, Oklahoma City, is the Program Chairman, and Mr. Winfield Evans, Radiation Physicist at St. Anthony Hospital, Oklahoma City, is in charge of arrangements.

GREATER SAINT LOUIS SOCIETY OF RADIOLOGISTS

The Greater Saint Louis Society of Radiologists has elected the following officers for the coming year; President, Hugh Harting, M.D.; Vice-President, Armand E. Brodeur, M.D.; Secretary-Treasurer, William E. Powers, M.D.; 510 S. Kingshighway, St. Louis 10, Mo.

MIAMI VALLEY RADIOLOGICAL SOCIETY OF DAYTON, OHIO

The new President of the Miami Valley Radiological Society of Dayton, Ohio, is Hal D. Robertson, M.D. Other officers are Gamble S. Hall, M.D., President-Elect; John DeBold, M.D., Vice President; William D. Roberts, M.D., 1030 Reibold Bldg., Dayton 2, Ohio, Secretary-Treasurer.

NORTH FLORIDA RADIOLOGICAL SOCIETY

The North Florida Radiological Society recently elected as President, Paul A. Mori, M.D., and as Secretary, Charles H. Newell, M.D., both of the Baptist Memorial Hospital, 800 Miami Road, Jacksonville.

HOUSTON RADIOLOGICAL SOCIETY

New officers of the Houston (Texas) Radiological Society are: President, Charles W. Yates, M.D.; Vice-President, Robert S. MacIntyre, M.D.; Secretary, John Douglas Reeve, M.D., Texas Medical Center Library, Jesse H. Jones Library Bldg., Houston 25, Texas; Treasurer, Gerald D. Dodd, M.D.

VIRGINIA RADIOLOGICAL SOCIETY

At a recent meeting of the Virginia Radiological Society, John Rogers Mapp, M.D., Nassawadox, became President. Other officers are: President-Elect, John A. Cocke, M.D., Norfolk; Secretary-Treasurer, Powell G. Dillard, Jr., M.D., 715 Church St., Lynchburg; Councilor to the American College of Radiology, George Cooper, Jr., M.D., Charlottesville; Alternate Councilor, John A. Martin, M.D., Roanoke.

CANADIAN ASSOCIATION OF RADIOLOGISTS

At the Twenty-fourth Annual Meeting of the Canadian Association of Radiologists, Dr. Arthur E. Childe, of Winnipeg, retired as President. The new officers, all of Montreal, are: Donald L. McRae, M.D., President; Guillaume Gill, M.D., Vice-President; Robert G. Fraser, M.D., 687 Pine Ave., W., Montreal 2, Honorary Secretary-Treasurer; Jean-Louis Leger, M.D., 1560 Sherbrooke St. E., Montreal 24, Associate Honorary Secretary-Treasurer. The Central Office of the Association is 1555 Summerhill Ave., Montreal 25, Quebec.

The 1962 Annual Meeting will be held in Winnipeg, with scientific sessions beginning Jan. 22 and continuing through Jan. 24, at the Marlborough Hotel.

COURSE IN RADIOLOGY OF THE CHEST INDIANA UNIVERSITY

The Department of Radiology of the Indiana University School of Medicine announces a postgraduate course in Radiology of the Chest to be given April 6–9, 1961, at the Medical Center in Indianapolis. Although planned primarily for the general radiologist it is open to all physicians having an interest in this field. Presentations will consist of lectures, panel discussions, and film interpretation

Officers of the Canadian Association of Radiologists. Left to right, front row: Dr. Arthur E. Childe, Retiring President; Dr. Donald L. McRae, President; Dr. Guillaume Gill, Vice-President. Back row, left to right, Dr. Robert G. Fraser, Honorary Secretary-Treasurer; Dr. Jean-Louis Leger, Associate Honorary Secretary-Treasurer.

conferences, correlating the radiologic, pathologic, and physiologic aspects of various chest conditions encountered in clinical practice. Guest participants include Drs. Robert P. Barden, William R. Eyler, Benjamin Felson, Melvin M. Figley, C. Allen Good, John F. Holt, Harold G. Jacobson, and Averill A. Liebow of this country, and Dr. George Simon of London, England.

Further information regarding this course may be obtained from the Director of Postgraduate Medical Education, Indiana University School of Medicine, Indianapolis 7, Ind.

Books Received

Books received are acknowledged under this heading, and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

ANGIOGRAPHY. Edited by HERBERT L. ABRAMS, M.D., Associate Professor of Radiology; Director, Division of Diagnostic Radiology, Stanford University School of Medicine, Stanford, Calif. Foreword by Henry S. Kaplan, M.D., Professor of Radiology, Stanford University School of Medicine. With 32 contributors. Two volumes totaling 808 pages, with 1,345 photographs and line drawings on 610 figures. Published by Little, Brown & Co., Boston 6, Mass., 1961. Price $47.50.

CLINICAL USE OF RADIOISOTOPES: A MANUAL OF TECHNIQUE. Edited by THEODORE FIELDS, M.S., F.A.C.R. (Assoc.), Chief, Physics Section, Radioisotope Service, Veterans Administration Hospital, Hines, Ill.; Instructor in Radiology, Northwestern University Medical School; Attending Physicist, Cook County Hospital, Chicago, Ill.; Certified Medical Nuclear Physicist, American Board of Radiology, and LINDON SEED, M.D., Clinical Associate Professor of Surgery, University of Illinois College of Medicine; Director of Isotope Laboratories, Augustana Hospital, Chicago, Ill., and Oak Park Hospital, Oak Park, Ill.; Consultant in Radioisotopes, Veterans Administration Hospital, Hines, Ill. A volume of 476 pages,

with 77 figures. Published by The Year Book Publishers, Inc., Chicago 11, Ill., 2d ed., 1961. Price $10.50.

RADIATION PROTECTION AND DENTISTRY. By ARTHUR H. WUEHRMANN, D.M.D., University of Alabama School of Dentistry, Birmingham, Ala. The Postgraduate Dental Lecture Series. A monograph of 238 pages, with 48 figures. Published by C. V. Mosby Co., St. Louis 3, Mo., 1960. Price $6.50.

THE CHOICE OF A MEDICAL CAREER: ESSAYS ON THE FIELDS OF MEDICINE. Edited by JOSEPH GARLAND, M.D., Sc.D.(Hon.). Editor, *New England Journal of Medicine;* Consultant Editor, British *Practitioner*, and JOSEPH STOKES, III, M.D., Associate in Preventive Medicine, Harvard Medical School; Associate Editor, *New England Journal of Medicine*. A volume of 232 pages. Published by J. B. Lippincott Co., Philadelphia 5, Penna., 1961. Price $5.00.

THE HAZARDS TO MAN OF NUCLEAR AND ALLIED RADIATIONS. A Second Report to the Medical Research Council. Presented to Parliament by the Lord President of the Council and Minister for Science by Command of Her Majesty, December, 1960. Cmnd. 1225. A paper-bound monograph of 154 pages. Published by Her Majesty's Stationery Office, London, England, 1960. Price 7s. 0d. net.

SAFE HANDLING OF RADIOISOTOPES: HEALTH PHYSICS ADDENDUM. By G. J. APPLETON and P. N. KRISHNAMOORTHY. Safety Series No. 2. A manual of 120 pages, with numerous figures. Published by International Atomic Energy Agency, Kärntner Ring, Vienna I, Austria, 1960. Distributed in the United States and Canada by the National Agency for International Publications, Inc., and UNESCO Publications Center, 801 Third Ave., New York 22, N. Y. Price $1.50.

SAFE HANDLING OF RADIOISOTOPES: MEDICAL ADDENDUM. By F. HERČÍK and DR. H. JAMMET. Safety Series No. 3. A manual of 80 pages. Published by International Atomic Energy Agency, Kärntner Ring, Vienna I, Austria, 1960. Distributed in the United States and Canada by the National Agency for International Publications, Inc., and UNESCO Publications Center, 801 Third Ave., New York 22, N. Y. Price $1.50.

SEMEIOTICA STRUMENTALE DELLE VIE BILIARI. By A. INFRANZI, G. ESPOSITO, and S. DI GAETA. Foreword by Prof. Ettore Ruggieri. Preface by Prof. Pierre Mallet-Guy. A volume of 518 pages, with 250 figures. Published by Minerva medica, Turin, Italy, 1960.

Book Reviews

KLINISCHE NEURORADIOLOGIE. Edited by PROF. DR. KURT DECKER, München. Co-Authors: K. DECKER, H. FISCHGOLD, V. H. MARK, D. L. MCRAE, J. METZGER, H. SCHUNK, J. M. TAVERAS, O. WIEDENMANN. A volume of 508 pages, with 1,428 illustrations on 550 figures. Published by Georg Thieme, Herdweg 63, (14a) Stuttgart, Germany, 1960. Distributed in the United States and Canada by Intercontinental Medical Book Corporation, New York 16, N. Y. Price DM 230.—($54.75).

This is a superb volume which merits well the plans of the publisher and the authors to obtain a translation into English. Indeed, these men would be derelict if they failed to make the work available to an English-reading audience. The book consists of a series of treatises furnishing a wide perspective of neuroradiology for study and reference. Excessive details do not clutter the pages to stifle the interest of a busy clinician.

Herman Fischgold and Jean Metzger are granted the honor of the first treatise, on the routine examination of the skull. The material is presented simply, briefly, and in the usual form. The five standard skull projections: both laterals, anteroposterior, Towne's, and an axial view are recommended for the initial survey. Stereoscopic views are not advised. A detailed anatomic description of the base of the skull with a chart of eponymic syndromes which involve the cranial nerves is given. Mention is made of the various optic foramina views. Studies of the petrous pyramids, of the numerous optic foramina, and of basilar impression are included.

Dr. Kurt Decker of Munich, the editor and the one to whom we are indebted for the bulk of the text, contributes the next six monographs. Under cerebral contrast studies, the technic of carotid and vertebral arteriography precedes the elucidation of proper methods of roentgenography. There are illustrations of a large number of normal vascular patterns. Pneumography both by ventricular puncture and by the encephalographic technic is discarded. Several paragraphs pertain to the hazards of angiography and encephalography. In the chapter on roentgenography of the spinal canal, both air and gas myelography are mentioned, but the author favors the conventional Pantopaque studies, though he does describe and illustrate results obtained with water-soluble contrast material. The fourth chapter is on brain injuries, which include fractures, epidural and subdural hematomas, cerebral edema, and the sometimes forgotten brain fungus. One of the more extensive studies is that of the vascular brain disorders, which include a large number of radiographic reproductions illustrating such ailments as vascular occlusions, arteriosclerosis, mycotic aneurysms, primary and secondary hemor-

rhage, Sturge-Weber syndrome, and arteriovenous anomalies. Dr. Decker is apparently not acquainted with some of the American work in this field, particularly that of Gurdjian and Webster of Detroit and DeBakey of Dallas, Texas. Dr. Decker's chapter on neuropsychiatric disease is of particular interest because under our philosophy we do not separate this group of ailments. By neuropsychiatric disorders, the author refers to those organic disease states of the brain in which the psychopathic picture predominates. These include Alzheimer's disease, Pick's disease, the alcoholic psychoses, those incidents of mental retardation that are accompanied by developmental anomalies, syringomyelia, tuberous sclerosis and, on some occasions, syphilis of the central nervous system. Paget's disease, postmeningitic states, cerebral parasites, and functional disturbances are also discussed.

With Dr. Jean Metzger, Dr. Decker considers tumors of the orbit, exophthalmos, and tumors of the neck in so far as they are related to neuroradiology. Then, with Oscar Wiedenmann of Munich, he turns to anomalies, diseases, and injuries of the vertebral column. He is also co-author, with Dr. Wiedenmann, of a chapter on spinal cord tumors.

The more specialized studies of the skull are provided by four new-world physicians. Dr. D. L. McRae of Montreal presents the current views on epilepsy and related convulsive disorders. He also submits his studies on the intervertebral disk, particularly when, as a result of prolapse, it encroaches on the spinal canal. Dr. J. M. Taveras, of New York City, writes on pediatric neuroradiology. Craniostenosis, cranium bifidum, hydrocephalus, and Lückenschädel are treated in masterly fashion. Microcephaly, brain tumors, and the peculiar results of injury to the infant skull are not overlooked.

An amazingly precise and unusual specialization is that of stereotaxis. Herbert Schunk and Vernon Mark of Boston describe their method of destroying certain portions of the brain by electrocautery, a procedure that is now mostly used in connection with parkinsonism. They state that with their stereotaxic apparatus, they can aim and angle the electrodes, utilizing the appropriate roentgenograms, to an amazing degree of accuracy, at times as close as 0.5 mm. Their chief source of error lies in anatomic variations within the brain and not in the available equipment.

This is a large, well bound book, profusely illustrated with clear roentgenograms, drawings, and photographs. If one were grading it, it would surely rate an A-plus.

DIAGNOSE UND DIFFERENTIALDIAGNOSE IN DER SCHÄDELRÖNTGENOLOGIE. By PROF. DR. ERNST G. MAYER, Vorstand des Zentral-Röntgeninstitutes (Guido-Holzknecht-Institut) der Universität Wien. A volume of 600 pages, with 584 illustrations on 376 figures with legends in German, English, Spanish, and French. Published by Springer-Verlag, Mölkerbastei 5, Vienna 1, Austria, 1959. Price $46.20.

The opening 190 pages of this book comprise the text, while the remaining 400 pages constitute an atlas. The leading topics discussed are the normal radiography of the skull, osseous anatomic variants, intracranial diseases, radiology of the paranasal sinuses, ophthalmic radiology, otologic examinations and traumatic changes. These subjects are moderately well covered, in good, clear German. Since this is not definitive writing, it is brief enough to be easily readable in two or three evenings. The descriptive material in the atlas is in four languages. The illustrations individually are sharp, clear, and appropriate to the topic for which they were selected.

This quadrilingual atlas greatly increases the distribution potential of the book. The German descriptions are translated into English, French, and Spanish, each of the four languages receiving equal space. This same language expansion, along with the wide spacing of the illustrations, expands the size of the atlas, perhaps disproportionately. With more economical apportionment of illustrations and unilingual legends, the number of pages could probably be reduced to half the present number.

The quality throughout—printing, paper, binding, illustrations and text—is excellent. The purchaser should realize however, that he is getting a book which is perhaps meritoriously but nevertheless artificially expanded.

ABSTRACTS OF CURRENT LITERATURE

ROENTGEN DIAGNOSIS

The Head and Neck

LEWTAS, N. A. Venous Changes in Central Brain Tumours 493

ROGERS, VINCENT. Vertebral Angiography in the Diagnosis of Meningioma Within the Lateral Ventricle 493

CECCHINI, A. The Radiologic Appearance of Acoustic Neurinoma: A Review of 68 Cases 493

BEGG, A. C. Some Radiological Aspects of Ischaemia of the Brain 494

WELIN, SÖLVE. Roentgen Diagnosis of Paranasal Sinuses 494

DOHLMAN, GÖSTA, AND MATTSSON, OVE. The Endoscopic Operation for Hypopharyngeal Diverticula. A Roentgencinematographic Study 494

COMPERE, W. E., JR. Radiologic Findings in Otosclerosis 495

COMPERE, W. E., JR. The Radiologic Evaluation of Eustachian Tube Function 495

OPPENHEIM, H., AND WING, M. Sialography and Surface Anatomy of the Parotid Duct 495

The Chest

BERKSON, JOSEPH, ET AL. Identification of "Positives" in Roentgenographic Readings 496

DÖPPER, TH. Roentgen Diagnosis of Injuries of the Thorax Due to Blunt Trauma 496

KASSAY, DEZSO. Observations on One Hundred Cases of Bronchial Foreign Body 496

TSAI, S. H., ET AL. Bronchographic Patterns Following Resection for Pulmonary Tuberculosis 497

WILLICH, E. Changes in Pneumonia in Children as Seen on the Chest Film 497

CHRISTOFORIDIS, ANTHIMOS J., AND MOLNAR, WILLIAM. Eosinophilic Pneumonia. Two Cases with Biopsy 498

HARRISON, EDGAR G., JR., ET AL. Pulmonary Alveolar Proteinosis. Case with Fatal Outcome 498

WELCH, C. CHARLES, AND CANADA, ROBERT O. Sarcoidosis. Experience at a Naval Hospital 498

TOIGO, ANGELO. Pulmonary Aspergillosis 498

WEBSTER, B. H. Pleuropulmonary Amebiasis. A Review with an Analysis of Ten Cases 499

RAO, R. VENKATESWARA. X-ray Diagnosis of Hydatid Cyst of the Lung: Its Rupture into the Bronchus and Spontaneous Healing 499

VOGEL, K.-H., AND FLINK, E. Roentgen Changes in the Thorax in Periarteritis Nodosa 499

HARTWEG, H. Roentgen Findings in the Thorax in the Chronic Leukoses 500

SCHRÖDER, W. Objective Diagnostic Routine for Pulmonary Emphysema 500

FOUCHÉ, R. F., AND D'SILVA, J. L. Hypertransradiancy of One Lung Field and Its Experimental Production by Unilateral Miliary Embolisation of Pulmonary Arteries in Cats. 501

PITTMAN, HELEN S. Gamma Globulin Concentrations in Ambulatory Patients with Bronchiectasis, with Report of One Case of Agammaglobulinemia Treated for Four Years 501

The Heart and Blood Vessels

DI GUGLIELMO, L., AND TRENTA, A. A New Radiologic Sign of Myocardial Infarct 501

BARRETT, A. F., AND VERNEY, G. I. Kinking of the Aortic Arch Associated with Fusiform Aneurysmal Dilation 502

HERBST, M., ET AL. Supravalvular Aortic Stenosis with Hypoplasia of the Aorta 502

DEMOULIN, M. Disco-Vertebral Necrosis After Aortography 502

TRACY, G. D., ET AL. Correlation of Radiographic Findings with Clinical Features of Degenerative Arterial Disease 502

SUTTON, DAVID. Arteriography in Dissecting Aneurysm 503

DESHMUKH, MADHUKAR, ET AL. Idiopathic Dilatation of Pulmonary Artery 503

WANG, C. C., AND REEVES, JOHN D. Mesenteric Vascular Disease 504

NELSON, SIDNEY W., AND EGGLESTON, WILLIAM. Findings on Plain Roentgenograms of the Abdomen Associated with Mesenteric Vascular Occlusion with a Possible New Sign of Mesenteric Venous Thrombosis 504

ABSOLON, KAREL E., ET AL. Experimental Study of the Diagnosis of Mesenteric Infarction... 505

SUSMAN, NOAH, AND SENTURIA, HYMAN R. Gas Embolization of the Portal Venous System.. 505

KALOKERINOS, JAMES, AND TRACY, G. D. Techniques of Arteriography 505

The Digestive System

KEATS, THEODORE E. Traumatic Transthoracic Diaphragmatic Herniation of the Stomach.. 505

KHILNANI, MANSHO T. Calcifying Mucous-Cell Carcinoma of the Stomach 506

LUST, FRANZ J., AND HEIMLICH, HENRY J. Roentgenographic Findings in an Early Case of Linitis Plastica 506

GREENSPON, EDWARD A., AND LENTINO, WALTER. Retrograde Enterography 506

SAVAGE, PAUL T. The Management of Acute Intestinal Obstruction: 179 Personal Cases 507

SASSON, LEON. Entrance of Barium into Intestinal Glands During Barium Enema... 507

POPPEL, M. H. Duodenocolic Apposition 507

SCHWARZ, ENRIQUE. Diagnostic Value of Radiography in Volvulus of the Colon 508

ANDRÉN, L., AND WELIN, S. Frequency of Polyps of the Colon in Ulcerative Colitis 508

FORRESTER, HENRY C., AND SOULE, A. BRADLEY. Value of Routine Lateral Rectal Projection in Barium Enema Study 508

SHAVER, WARD. Accuracy of Routine Gallbladder and Bile-Duct Studies 509
ALDERSON, D. A. Reliability of Telepaque Cholecystography 509
O'LACO, J. P., AND WILCOX, WILLIAM A. A Comparative Clinical Evaluation of a New Oral Cholecystographic Medium, Orabilex, with Telepaque 509
SACHS, MAURICE D., AND PARTINGTON, PHILIP F. The Distended Gallbladder: Value of a Fat Meal in Cholecystography 509
DWORKEN, HARVEY J. Recent Experiences with Spontaneously Disappearing Gallstones 510
OCHSNER, SEYMOUR F., AND OCHSNER, ALTON. Benign Neoplasms of the Gallbladder 510
THEANDER, GEORG. Pseudoconcretions in Precipitate of Contrast Medium in the Gallbladder 510
KAPLAN, ALLAN A., ET AL. Percutaneous Transhepatic Cholangiography 511
FLOCH, MARTIN H., AND GEFFEN, ABRAHAM. Intravenous Cholangiography with Sodium Iodipamide: The Problem of Nonvisualization 511
EDHOLM, PAUL. Effect of Secergan on the Duodenum and Common Bile Duct 511

The Musculoskeletal System

MONTGOMERY, R. D., AND STANDARD, K. L. Albers-Schönberg's Disease. A Changing Concept 512
JEANMART-MICHEZ, LOUIS. Osseous Localizations of Eosinophilic Granuloma 512
HASEGAWA, JUNJI, AND IHRKE, ROYAL E. Tuberous Sclerosis Complex. Unusual Case of Adenoma Sebaceum, Tuberous Sclerosis, and Extensive Bone Lesions 512
DAVIS, ARTHUR E., JR. Simultaneous Occurrence of Osteitis Deformans and Hodgkin's Disease 512
MUSTARD, W. T. Scoliosis: Diagnosis and Natural History 513
O'CONNELL, JOHN E. A. Intervertebral Disk Protrusions in Childhood and Adolescence .. 513
HARRIS, LLOYD E., ET AL. Early Diagnosis of Congenital Dysplasia and Congenital Dislocation of the Hip. Value of Abduction Test. 513
SWEETNAM, D. R., ET AL. Steroid Arthropathy of the Hip 514
ALEXANDER, COLIN. Erosion of the Femoral Shaft Due to Patello-Femoral Osteoarthritis. 514
RENNIE, A. M. Pathology of Slipped Upper Femoral Epiphysis. A New Concept 514
WEINBERG, H., ET AL. Familial Epiphysial Dysplasia of the Lower Limbs 515

The Genitourinary System

BÉRAUD, CL., ET AL. Value of Tomography in the Urographic Study of Infants and Children .. 515
DOLAN, PATRICK A., AND KIRKPATRICK, W. E. Multiple Ureteral Diverticula 515
ROSS, J. COSBIE, ET AL. Ureteric Reflux in the Paraplegic 515
PAQUIN, ALBERT J., JR., ET AL. The Megacystis Syndrome 516
STEWART, CHARLES M. Congenital Bladder Neck Obstruction: Diagnosis by Delayed and Voiding Cystography; Use of a New Cold, Crush-Cutting Punch 516

The Adrenals

LUND, RONALD R., ET AL. Inferior Vena Cavography in Preoperative Localization of Pheochromocytoma 517

RADIOTHERAPY

LOEFFLER, R. KENNETH. Place of Radiation Therapy in the Treatment of Cancer 517
LIPPINCOTT, STUART W., ET AL. Radiation Effects of Neutron-Capture Therapy on a Malignant Vascular Neoplasm of the Cerebellum. Histopathological Observations 517
VAN DEN BRENK, H. A. S., AND MINTY, C. C. J. Radiation in the Management of Keloids and Hypertrophic Scars 517
LAMB, JOHN H., AND MINOR, DWANE B. Carcinoma of the Oral Cavity 518
OBERHEUSER, FRIEDHELM, ET AL. Electron-Beam Therapy of Malignant Tumors of the Mouth and Jaw 518
ACKLAND, T. H., ET AL. The Management of Early Breast Cancer 519
POPPE, HANNO, AND GREGL, ANTON. Value of an Early Change in Hormonal Status through Suspension of Ovarian Function and Application of Androgens in the Therapy of Advanced Mammary Carcinoma. Prophylactic X-ray Castration in 284 Patients 519
WALTER, J. Giant-Cell Lesions of Bone. Osteoclastoma and Giant-Cell Tumour Variants .. 519
LEGRÉ, J., AND SERRATRICE, G. Radiologic Aspects of Primary Tumors of the Spine and Their Treatment; 40 Cases 520
SCHUBERT, GERHARD, ET AL. Betatron Therapy of Gynecologic Cancers 520
BUTTENBERG, DIETRICH. Adenocarcinoma of the Uterine Cervix 520
GRAHAM, RUTH M. Cytologic Prognosis in Cancer of the Cervix 521
ARRONET, G. H., ET AL. Primary Carcinoma of the Vagina 521
FEINBERG, S. R. Dysgerminoma of the Ovary: Unusual Roentgen Manifestation of Metastases 522
KRATOCHWIL, ALFRED, ET AL. Artificial Menopause with the Aid of Ionizing Rays 522
BROWN, EDWIN W. Eosinophilic Granuloma of the Bladder 522
GHOSE, SANDHYA, AND CHATTERJEA, J. B. Chronic Myeloid Leukaemia: 116 Cases ... 522
PROCTER, N. M., AND GREENING, J. R. Adequacy of Half-Value Layer as a Criterion of X-Ray Quality in the Calibration of Dosemeters ... 523

VOROBIEV, E. I. Organization of Radiotherapeutic Service for the [Russian] Population.. 523

RADIOISOTOPES

HOWARD, N., ET AL. A Comparison of the 15-Minute Continuous Thyroid Uptake Test with Other Radioiodine Tests..... 523
WALKER, W. F., ET AL. Clinical Assessment of Intestinal Fat-Absorption Using Radioactive Fat..... 524
STRAFFON, RALPH A., AND GARCIA, ANTONIO M. Clinical Evaluation of the Radioactive Diodrast Renogram as a Screening Test in Hypertension..... 524
ZILIOTTO, D. Hepatography and the Study of the Liver Function by Means of I^{131} Tagged Rose Bengal..... 524
COTTAFAVI, M., AND MENTASTI, P. Amniotic Circulation Studied with I^{132}..... 525
COHEN, M., ET AL. Physical Aspects of Cobalt 60 Teletherapy Using Wedge Filters..... 525
POTTER, G. D., ET AL. Induction of Neoplasms in Rat Thyroid Glands by Low Doses of Radioiodine..... 525
UHLEY, HERMAN N., ET AL. Radioautography of the Conduction System of the Dog's Heart with I^{131}..... 526
NEWLAND, H. W., ET AL. Placental Transfer of Phosphorus in Sows Maintained on High and Low Levels of Dietary Manganese..... 526
BONNET, JOHN D., ET AL. Rate of Loss of Radioiron from Mouse and Man..... 526
CARLSON, CURTIS H., ET AL. Renal Excretion of Radiofluoride in the Dog..... 526
GROOS, EKKEHARD. Strontium-90 Content of Fodder and Milk..... 527

RADIATION EFFECTS

HOOPER, F. M. Radiation Hazards in X-Ray Diagnosis..... 527
HOWARD, RUSSELL. Carcinoma of the Thyroid Gland in Childhood: Its Relation to Radiotherapy..... 527
GYORKEY, JOSEPH, AND POLLOCK, FREDERIC J. Radiation Necrosis of the Ossicles..... 527
BIRCH, ANN MCA., AND BAKER, DAVID H. Effect of Repeated Fluoroscopic Examinations on 1480 Children with a Long-Term Follow-Up Study..... 528
LAMERTON, L. F., ET AL. Effects of Protracted Irradiation on the Blood-Forming Organs of the Rat. I: Continuous Exposure..... 528
BACHOFER, C. S., AND GAUTEREAUX, M. E. Bioelectric Responses in Situ of Mammalian Nerves Exposed to X-Rays..... 529
DARDEN, EDGAR B., JR. Changes in Membrane Potentials, K Content, and Fiber Structure in Irradiated Frog Sartorius Muscle..... 529
NEWSOM, BERNARD D., AND KIMELDORF, DONALD J. Species Differences in Altitude Tolerance Following X-Irradiation..... 529
LANGENDORFF, HANNS, ET AL. Biologic Protection Against Repeated Lethal Total-Body Exposure Doses..... 529
PATERSON, RALSTON, ET AL. Relative Biological Efficiency of 20 MV and 4 MV Radiations. Report from the Medical Research Council Group, Christie Hospital, Manchester (England). I–VII..... 530
ERSHOFF, BENJAMIN H., AND BRAT, VED. Comparative Effects of Prenatal Gamma Radiation and X-Irradiation on the Reproductive System of the Rat..... 530
SEMENOV, L. F. Testing of Indoleamine Compounds in the Prevention of Radiation Illness 530

ROENTGEN DIAGNOSIS

THE HEAD AND NECK

Venous Changes in Central Brain Tumours. N. A. Lewtas. Clin. Radiol. (J. Fac. Radiologists) **11:** 93–99, April 1960. (United Sheffield Hospitals, Sheffield, England)

The cerebral venous circulation can be divided into two parts—the *superficial* veins draining into the longitudinal and transverse sinuses and the *deep* veins. The latter include the thalamostriate, septal, and internal cerebral veins, the vein of Galen, and the vein of Rosenthal. The demonstration of abnormalities in position of the deep veins is particularly helpful in the diagnosis of central brain tumors. These lesions are frequently silent in the early stages, and the first symptoms may be those of increased pressure due to obstruction by the tumor of the third ventricle and aqueduct. Clinically, localizing signs of the tumor are often false or unreliable, and air studies, except as a preoperative measure, are considered hazardous. The deep veins can always be demonstrated in cerebral angiograms, and, since they remain outlined from the fourth to tenth second after injection (Greitz. Acta radiol. **46:** 285, 1956. Abst. in Radiology **68:** 882, 1957), multiple serial views are unnecessary as a routine. The anatomy of both the superficial and deep cerebral veins is discussed.

Peripheral masses produce general displacement of the deep veins *en bloc*, the normal contours being maintained. Central tumors situated near these veins produce local deformities of their outline. In the anteroposterior projection, the internal cerebral vein is a far more delicate index of lateral displacement than the anterior cerebral artery: The slightest displacement of the internal cerebral vein across the midline is pathological, as normally it lies slightly to one side. Slight rotation of the head does not affect the vein due to its central position in the skull. Central, parietal, and occipital masses usually cause much displacement of the deep veins in contrast to the anterior cerebral artery, which often remains in the midline. Furthermore, the normal undulations of the anterior cerebral artery are sometimes difficult to distinguish from minor degrees of displacement of that vessel.

Frontal masses displace the venous angle posteriorly, resulting in compression and buckling of the internal cerebral vein. In most cases the diagnosis is apparent from the arteriogram, which shows characteristic bowing of the anterior cerebral artery to the contralateral side.

Parietal and *occipital* tumors displace the internal cerebral vein further across the midline than the anterior cerebral artery. In the lateral view the vein is displaced downward, with flattening of its normal curvature.

In *temporal* tumors, the arterial phase is usually diagnostic, upward displacement of the middle cerebral artery being readily apparent. Elevation of the thalamostriate vein with widening of the venous angle and elevation of the basal vein may result from infiltration of the basal ganglia, indicating that complete removal of the tumor would be impossible.

Frequently the only arterial changes in *central* tumors are those of hydrocephalus. Localization of central tumors is often possible, however, from the venous changes. Deep anterior tumors situated in the septum lucidum, corpus callosum, and caudate nuclei displace the foramen of Monro and venous angle backward. With basal tumors involving the thalami the venous angle is displaced upward, backward, and laterally. The thalamostriate vein is elevated by tumors in the thalamus, producing a widely open venous angle. Conversely, masses in the frontal lobe depress the thalamostriate vein, thus closing the venous angle.

Measurements of the venous angle and position of the internal cerebral vein on lateral projections are considered unreliable due to the wide limits of normal variation. The venous patterns, like the arterial distribution, must be studied as a whole. The only exception to this is in contralateral displacement of the internal cerebral vein across the midline in the anteroposterior view. When this is demonstrated, the author has found it to be unequivocal evidence of a mass lesion.

Thirteen roentgenograms; 3 photographs.

SAMUEL B. HAVESON, M.D.
Lynwood, Calif.

Vertebral Angiography in the Diagnosis of Meningioma within the Lateral Ventricle. Vincent Rogers. Brit. J. Radiol. **33:** 326–328, May 1960. (Salford Royal Hospital, Salford, Lancs., England)

The author reports the case of a 47-year-old woman who had a surgically verified meningioma within the left lateral ventricle. A right carotid angiogram showed a doubtful shift of the anterior cerebral artery to the right. In an attempt to inject the left carotid artery the needle entered the vertebral artery and the resulting arteriogram disclosed a tumor. In the lateral views the arterial phase revealed large elongated posterior choroidal arteries, one of which was bowed forward, demarcating the anterior edge of the tumor mass. There was slight depression of the posterior cerebral artery, and its medial parieto-occipital branches were seen to curve upward around the posterior edge of the tumor. The venous phase showed an early tumor circulation, which on the later phase revealed itself as an extensive tumor "blush" measuring approximately 7 × 4.5 cm. In the anteroposterior films the arterial phase was not particularly helpful, but in the later phase a tumor "blush" was demonstrated, having a definite edge medially though its lateral extent was difficult to ascertain.

Lateral ventricle meningiomas arise from the choroid plexus and receive their blood supplies from the arteries supplying that structure. The choroid plexus of the inferior horn of the lateral ventricle is supplied by the anterior choroidal artery, a branch of the internal carotid artery. The posterior choroidal arteries, branches of the posterior cerebral artery, form the main supply to the body and posterior horn of the lateral ventricle. Therefore, a lateral ventricle meningioma may escape diagnosis unless vertebral angiography is done.

Only 5 other cases of meningioma of the lateral ventricle in which the diagnosis was established by vertebral angiography have been recorded.

Four roentgenograms. PHILIP M. JOHNSON, M.D.
Montclair, N. J.

The Radiologic Appearance of Acoustic Neurinoma: A Review of 68 Cases. A. Cecchini. Radiol. med., Milan **46:** 183–199, February 1960. (Istituto Neurologico di Milano, Milan, Italy)

Sixty-eight cases of acoustic neurinoma were operated

upon at the Neurologic Institute of Milan between 1940 and 1957. The author evaluates the findings on the plain roentgenogram in these cases. Bone changes were classified as *local*, produced by the tumor itself, and *indirect*, produced by elevation of intracranial pressure.

Localized bony changes produced by the tumor itself were found in 56 (82.3 per cent) of the 68 patients. On the basis of the roentgenologic findings, the patients were divided into three groups. In the first group (9 cases), significant changes were found in the petrous pyramid, ranging from amputation of the apex of the pyramid to extensive or even complete destruction of the internal acoustic canal. In the second group (44 cases), changes were localized to the internal acoustic canal and ranged from slight decalcification to reactive changes with sclerosis, widening, and deformity. In the third group (3 cases), isolated changes localized to the tip of the petrous pyramid were seen.

In 12 patients, there were no localized bony changes. In 5 of these, however, changes produced by generalized elevation of intracranial pressure were seen.

Changes due to increased intracranial pressure were found in 35 of the 68 patients (51.5 per cent) and were manifested by alterations in the sella turcica which in themselves were not characteristic of acoustic neurinoma.

Both the local changes and those due to increased intracranial pressure were related directly to the size of the tumor. No direct relationship could be established, however, between the tumor size and the localized bony changes produced. Some very large tumors develop in the cerebellopontine angle without causing significant focal lesions. No definite relationship was established in the present series between the duration of symptoms and the severity of the radiologically demonstrated lesions, local or general.

Eleven roentgenograms; 6 tables.

ALEXANDER R. MARGULIS, M.D.
Washington University School of Medicine

Some Radiological Aspects of Ischaemia of the Brain. A. C. Begg. Brit. J. Radiol. **33:** 311–315, May 1960. (Dunedin Hospital, Dunedin, N. Z.)

The effects of ischemic disease of the brain due to arterial obstruction become more difficult to detect by clinical means the more centrally they are situated. The clinical picture is dependent upon the sum of the infinite anatomical variation in the circle of Willis, the situation and degree of obstruction, the adequacy of the anastomotic circulation, as well as general systemic disease. Ischemia-producing lesions of the arteries that supply the circle of Willis are better evaluated roentgenographically by catheterization technics than by direct puncture methods. Among the advantages of the former are: (1) opacification of the whole length of the vessels feeding the circle of Willis; (2) avoidance of mural trauma; (3) lower concentration of contrast medium in the brain; (4) less radiation to the operator. Frequently, the relative flow in each vessel may be estimated.

Vertebral System: Best results are obtained on the right side by catheterization of the brachial artery, with the tip of the catheter in the subclavian artery for right vertebral artery opacification or in the innominate artery if a simultaneous carotid arteriogram is desired. On the left side the catheter may be placed in the subclavian artery by either the brachial or femoral route. Rapid manual injection of 10 c.c. 60 per cent Urografin has been found satisfactory.

Carotid System: Catheterization of the innominate artery *via* the right brachial has proved useful for examining the right carotid system. On occasion, both carotid systems may be investigated by this means. The left common carotid may be investigated by catheterization *via* either femoral artery or by injection of the ascending aorta, by the brachial or femoral route. If injection of the aorta is carried out, 15 c.c. of 60 per cent Urografin has been used.

The author reports 3 cases in which catheterization arteriography demonstrated (1) partial atheromatous occlusion of the basilar artery, (2) osteophytic occlusion of the vertebral artery, and (3) bilateral subtotal carotid artery occlusion with increased vertebral artery flow.

Nine roentgenograms.

PHILIP M. JOHNSON, M.D.
Montclair, N. J.

Roentgen Diagnosis of Paranasal Sinuses. Sölve Welin. Minnesota Med. **43:** 325–328, May 1960. (Malmö Allmänna Sjukhus, Malmö, Sweden)

In this paper the author describes in detail the method of examination of the paranasal sinuses at the Malmö Allmänna Sjukhus, Malmö, Sweden. In routine studies roentgenograms are obtained at 5 angulations, at least 2 films being taken with a horizontal beam. In the investigation of neoplasms another projection has been found useful: the patient is prone with the chin and nose against the table and the tube is angled toward the feet at 15 degrees. The bony walls are then distinct all the way around and the great wing of the sphenoid can also be examined.

Osteomas are the most common of the benign tumors of the sinuses. Of greater importance from a differential diagnostic point of view are the fibro-osteomas in which pressure atrophy may be so severe that the roentgenogram can give the impression of a cancer accompanied by destruction.

By the time the patient with a malignant tumor comes to roentgen examination, there is usually a complete opacification of the affected sinus indistinguishable from that produced by fluid or thickened mucosa. The sinus walls must therefore be carefully examined for evidence of decalcification and destruction. Malignant tumors usually originate in the maxillary-ethmoidal angle and grow out toward the nasal sinus, the frontal sinus and orbits, or posteriorly toward the sphenoidal bone or through the posterior wall of the maxillary sinus out into the pterygopalatine fossa.

Treatment depends on how widespread the tumor is. If it is small and well defined, the best results are obtained by combined radiotherapy and surgery; only radiotherapy, however, can be offered in the presence of extensive involvement. Pathologic bone changes of the great wing of the sphenoid and of the pterygoid process imply that the tumor is too widespread for extirpation.

The Endoscopic Operation for Hypopharyngeal Diverticula. A Roentgencinematographic Study. Gösta Dohlman and Ove Mattsson. Arch. Otolaryng. **71:** 744–752, May 1960. (G. D., National Institutes of Health, Bethesda, Md.)

The advantages of the endoscopic operation for

hypopharyngeal diverticula are discussed, and attention is called to the contribution which roentgencinematography can make to the success of this procedure. The technic which the authors employ is described. With roentgencinematography, in which an image intensifier is used, the swallowing mechanism can be recorded in great detail without danger of radiation injury. Since the examination is more easily carried out than the ordinary radiographic study of the esophagus, it is less trying to the patient. When performed postoperatively, roentgencinematography permits an analysis of the functional result.

Frames are reproduced to illustrate how varying degrees of division of the esophagodiverticular wall can influence the subjective and objective symptoms. With cinematography it is possible to demonstrate to the surgeon the level of the threshold between the diverticulum and the esophagus and the degree of persistent retention in the pouch, and the necessity for further division of the esophagodiverticular wall can be judged.

Eighteen series of cinematographic frames; 3 photographs.

Radiologic Findings in Otosclerosis. W. E. Compere, Jr. Arch. Otolaryng. **71:** 150–155, February 1960. (511 S. Bonnie Brae, Los Angeles 57, Calif.)

Patients with diffuse otosclerosis involving the horizontal canal frequently have cochlear nerve involvement, and for this reason it is important for the otolaryngologist to be aware of the presence of diffuse otosclerosis before undertaking stapes fixation. When extensive otosclerosis is demonstrated in preoperative roentgenograms, the surgeon can be prepared to proceed with the utilization of prosthetic devices at the first procedure. In cases of far-advanced nerve-type deafness advanced hyperostosis of the petrosa is often demonstrable roentgenographically. These patients frequently have closed round windows and benefit from appropriate oval and round window surgery. In the interest of more accurate evaluation of candidates for mobilization and/or round window surgery, the author believes that preoperative roentgenograms should be obtained in all cases. Not only will the selection of patients be enhanced, but the patient scheduled for mobilization surgery will have a greater opportunity to obtain lasting benefit.

The lesions of diffuse otosclerosis can be demonstrated roentgenographically, in the Stenvers' position, in an appreciable number of cases. The changes which are manifest are: (1) local overgrowth of osseous tissue anywhere in the otic capsule; (2) apparent sclerosis of the entire otic capsule, almost obscuring the labyrinthine system in some instances; (3) hyperostosis of the entire petrous pyramid.

Fourteen roentgenograms.

The Radiologic Evaluation of Eustachian Tube Function. W. E. Compere, Jr. Arch. Otolaryng. **71:** 386–389, March 1960. (511 S. Bonnie Brae, Los Angeles 57, Calif.)

It is a prerequisite for tympanic cavity reconstruction that the eustachian tube be open not only to inflation but to the clearance of blood and debris from the tympanic cavity. The author describes a technic for visualizing the tube roentgenographically, if it is patent, and to roughly determine the length of time for cavity clearance: The external canal of the ear to be examined is cleansed with alcohol or other suitable antiseptic. When the tympanic membrane is intact, the cavity is first aspirated through the most inferior portion of the drum with a short-bevel, 25-gauge needle. Next, a contrast medium such as iodophenylundecylate (Pantopaque) or diatrizoate (Hypaque) sodium is injected into the middle ear through the same perforation and with the same type of needle. A roentgenogram is then taken in the Stenvers' position. If any delay occurs and the tube is functioning properly, the tympanic cavity may have already emptied before the film is obtained. After ten minutes, a second exposure is made, in the same position. If the drum has been perforated, the medium is injected into the middle ear through the existing perforation. After instillation of the fluid, the ear canal is closed with a plug of cotton saturated with petrolatum. This procedure has been carried out in over 100 ears with no serious untoward results.

If the tube is patent, it should be clearly visible on the roentgenogram; clearance should be complete in ten minutes. In the usual case of chronic secretory otitis media, the auditory tube is not demonstrable, and there is no clearance, even though, after removal of the secretion from the middle ear, the tube may be inflated with ease. In these cases the obstruction is in the tympanic portion of the tube. In other cases, where the tubal obstruction is in the nasopharynx, the eustachian tube is visualized easily and clearance is complete, but the patient is unable to inflate his ear.

The roentgen demonstration of tubal patency obviates the necessity of surgical exploration of the hypotympanum and tubal orifice during tympanoplastic procedures, whereas the failure to reveal tubal patency makes such exploration mandatory.

In a series of 30 patients who had tympanic cavity reconstructions six months previously, 78 per cent of those with normal clearance on tympanography maintained viable, intact grafts. Of those with obstructed tubes as demonstrated by tympanography, only 36 per cent maintained intact, viable grafts.

Nine roentgenograms.

Sialography and Surface Anatomy of the Parotid Duct. H. Oppenheim and M. Wing. Arch. Otolaryng. **71:** 80–83, January 1960. (VA Hospital, Louisville, Ky.)

After a brief discussion of the variations in the anatomy of the parotid gland and in the direction of Stensen's duct, the authors discuss the sialographic findings in 100 adults. In 78 persons in this group, the main parotid duct followed a line from one fingerbreadth above the angle of the mandible to the alarfacial junction. In 22 sialograms, the main duct took a more horizontal course, *i.e.*, from the tip of the ear lobe to the alarfacial junction. The midpoint of either line corresponded roughly to the orifice of the duct. In none of the roentgenograms did the duct follow a line downward from its origin in the gland.

In 39 of the roentgenograms the main duct of the parotid gland divided into two interlobar ducts, while in 61 it split into three or more branches within the gland. No accessory ducts were visualized in 39 cases; in 38 cases one accessory duct was demonstrated; in 7, two; in 6, three or more. All accessory ducts entered the main duct from above.

Two roentgenograms; 1 drawing.

THE CHEST

Identification of "Positives" in Roentgenographic Readings. Joseph Berkson, C. Allen Good, David T. Carr, and André J. Bruwer. Am. Rev. Resp. Dis. **81:** 660–665, May 1960. (The Mayo Clinic, Rochester, Minn.)

An investigation was undertaken to determine the reliability of readings of roentgenograms of the chest viewed successively, as with patients referred for roentgen study in the course of a medical examination. The objective was limited to the designation of a roentgenogram as "positive" or "negative," "positive" meaning the presence of a shadow indicating a pathologic condition of the lung, and "negative" denoting the absence of such a shadow. The conception is that there are roentgenograms which, if studied with sufficient care by competent radiologists, will be found to be "positive." Such roentgenograms may be read erroneously by a particular radiologist, but, if the pathologic shadow is indicated to him, he will agree on the positivity. All roentgenograms on which there was not agreement and which could be classed as doubtful were excluded from the investigation. Ninety-eight of 500 films had previously been designated as "positive" and 402 as "negative." They were viewed by 9 readers—5 radiologists and 4 specialists in diseases of the thorax—who did not know the number of positive films included First, each reader reviewed the series of single roentgenograms. Then each roentgenogram was matched with its corresponding stereoscopic film, and the series of 500 sets were arranged in a new random order, and each pair was viewed stereoscopically. A period of several months elapsed between these two viewings.

With single roentgenogram readings, the average for the 9 readers was 18.5 per cent for "false negatives" and 3.4 per cent for "false positives." This variability is of the same order of magnitude as obtained in previous similar investigations. The reading of stereoscopic roentgenograms resulted in an improvement, with the average for false negatives being reduced from 18.5 to 14.9 per cent and that for false positives from 3.4 to 2.5 per cent.

Five tables.

JOHN H. JUHL, M.D.
University of Wisconsin

Roentgen Diagnosis of Injuries of the Thorax Due to Blunt Trauma. Th. Döpper. Fortschr. a. d. Geb. d. Röntgenstrahlen **92:** 524–532, May 1960. (In German) (Flurstr. 17, Nuremberg, Germany)

The serious blunt injuries of the thorax are rupture of a bronchus and rupture of the parenchyma.

Rupture of a bronchus occurs particularly in young patients. The trauma usually is not severe enough to crush the thoracic cage but it may be so forcible and sudden that it exceeds the elasticity of the main bronchi, resulting in a tear. The automatic reflex closure of the glottis and the increased intrabronchial pressure at the instant of the injury probably act as contributing factors. The prognosis was formerly extremely poor, but recently the development of thoracic surgery has improved the outlook. Immediate surgical intervention is much superior to conservative treatment with its many complications.

The main diagnostic criteria of bronchial injury are tension pneumothorax, mediastinal emphysema, and absence of effusion. If the tension pneumothorax occurs early and is intense, a large bronchus is probably involved. If it occurs later, the tear is probably closer to the periphery. Mediastinal emphysema appearing early and increasing in spite of suction drainage of the pneumothorax almost certainly indicates a tear in one of the main bronchi. If emphysema develops later, it may be caused by a peripheral injury of the parenchyma, particularly if there are adhesions between the visceral and the parietal leaves of the pleura. X-ray examination should be done immediately upon arrival of the patient at the hospital, with follow-up films every few hours to show the further developments.

Injuries of the parenchyma in children may also occur without rib fracture or other injury of the thoracic cage. In adults it is usually a fractured rib that causes the parenchymal tear. Early diagnostic criteria are tension pneumothorax, bloody effusion in the thoracic cavity, and absence of a primary mediastinal emphysema. Later, atelectasis and secondary emphysema of the mediastinum or other parts of the body may occur. However, the various criteria may overlap.

The later the development of tension pneumothorax and mediastinal emphysema, the farther toward the periphery is the injury. The best evaluation for surgical intervention can be obtained if serial roentgenograms from the earliest possible moment are available. A definite indication for surgery exists if there is a tear in a large bronchus or blood vessel. If there is an injury of a peripheral bronchus or of the peripheral parenchyma, suction drainage should be instituted. If, after several hours of continued suction, no appreciable expansion of the lung occurs, surgery is to be considered.

Nine roentgenograms.

WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

Observations on One Hundred Cases of Bronchial Foreign Body. Dezso Kassay. Arch. Otolaryng. **71:** 42–58, January 1960. (740 School Line Drive, King of Prussia, Penna.)

The data on 100 cases of bronchial foreign body are presented in tabular form. Three-fourths of the patients were under six years of age. In the majority of instances, the foreign body was located in the main bronchus. The findings in these cases are discussed with particular reference to (1) the so-called Holzknecht sign of bronchial stenosis (inspiratory retraction of the mediastinum and heart into the affected chest cavity); (2) valvular emphysema; (3) atelectasis; and (4) inflammatory complications.

Holzknecht Sign: The importance of the inspiratory shift of the mediastinum and heart is stressed. This may be observed in cases of simple stenosis or valvular emphysema, as well as in atelectasis.

Valvular Emphysema and Atelectasis: The term valvular emphysema is considered more expressive and more applicable than the terms *ventilstenosis* (German) or obstructive emphysema. It is proposed that valvular emphysema be classified as complete, transitory incomplete, incomplete, and "portional." Generally, it may only be said that valvular emphysema appears when more air enters the alveoli than is absorbed, and by a reverse mechanism, atelectasis, due to obstruction, compression, contraction, or weakening of respiration, appears clinically when less air enters the alveoli than is absorbed.

Complications: Abscess occurs when a foreign body, either by spontaneous self-propulsion or from its smallness, reaches a small weak-walled bronchus. In

the development of bronchiectasis, the significance of the internal pressure of the stagnating pus and of the valvular action is apparent. The occurrence of bronchiectasis in different lobes and segments corresponds to the degree of inflammation found in lobes and segments of an atelectatic lung distal to an obstructed main bronchus. It seems that bronchiectasis in lobes or segments, even inside an occluded lung, is related to gravitational as well as to other factors.

It is concluded that in cases of bronchiectasis in segments of the lower lobe and/or in the middle lobe or lingula, the obstructing material may be located in a lobar or segmental bronchus or *in the main bronchus*. Thus, in a case of a lobar or segmental bronchiectasis without distinct stenosis in the supplying bronchus, bronchi from the tracheal carina down to the lobar or segmental bronchus must be searched for lesions or signs of earlier obstruction.

Forty-four roentgenograms; 1 photograph; 2 drawings; 4 tables.

Bronchographic Patterns Following Resection for Pulmonary Tuberculosis. S. H. Tsai, Sumner S. Cohen, and W. Y. Yue. Am. Rev. Resp. Dis. **81:** 26–42, January 1960. (Glen Lake Sanatorium, Oak Terrace, Minn.)

Pre- and postoperative bronchograms were reviewed in 52 patients from whom some pulmonary tissue was removed as part of the treatment for pulmonary tuberculosis. The resectional procedures ranged from wedge resection to bilobectomy. The postoperative bronchography was a routine investigation in 29 cases; in the remaining 23, bronchiectasis or bronchopleural fistula was suspected. The interval between resection and bronchography ranged between three to six months and seven and one-half years. With few exceptions, aqueous propyliodine (Dionosil) was the contrast medium. The authors' observations were as follows:

In order to fill the space created by excision of pulmonary tissue, the remaining segments and lobes undergo displacement and/or distention. The displacement is demonstrated by a shift of bronchi as visualized on bronchograms. The degree of change varies directly with the volume of lung removed, unless thoracoplasty is done at the time of surgery leaving little space to be filled by displacement or distention. The portions of lung anterior to the hilus (anterior segment, middle lobe or lingula, and anterior and medial basal segments) appear to play a more active role in the space-filling process than the dorsal segments. The right middle lobe and the lingula on the left are particularly noteworthy in this respect and often undergo the major shift because of their location and mobility. Upward displacement of the middle lobe may lead to angulation of a bronchus with poor drainage. The authors believe that this, along with stretching of pulmonary parenchyma, may cause reactivation of tuberculosis. They are inclined to think that thoracoplasty or other space-filling procedures should be considered where there is suspicion of residual reversible tuberculosis in the remaining lung most likely to become over-distended. Retention of secretion within the stump with subsequent mucosal damage, development of stitch abscesses, and eventual formation of bronchopleural fistula tend to occur in stumps with poor drainage or in those that are too long. Postoperative bronchiectasis in a previously uninvolved portion of the lung was not observed in this series.

Drawings of pre- and postoperative bronchograms in 20 of the patients accompany the paper and should be reviewed for details of bronchial shifts.

Eight roentgenograms are also reproduced.

JOHN H. JUHL, M.D.
University of Wisconsin

Changes in Pneumonia in Children as Seen on the Chest Film. E. Willich. Fortschr. a. d. Geb. d. Röntgenstrahlen **92:** 508–523, May 1960. (In German) (Zentralröntgeninstitut der Städt. Krankenanstalten, Bremen, Germany)

During the last two decades, new problems have arisen for the physician due to the appearance of new diseases and the changed character of others under the influence of chemotherapeutic and antibiotic medication.

Changes in the pneumonia of children have occurred because of increased resistance on the part of the infant as a result of better nutrition and because the character of the pneumonia itself had become more benign even before the advent of the antibiotics. Before the last war, 50 to 90 per cent of the pneumonias were due to pneumococci but the majority of cases are now attributable to staphylococci, mixed bacteria, or virus infections. Noteworthy also is the fungous pneumonia, which, prior to the use of antibiotics, was extremely rare. It produces soft, spotty densities with ragged edges, mainly in the middle and lower lung fields, and increased hilar shadows.

Most important are the pneumonias with abscess formation. These are caused for the most part by staphylococcic infections. The author has surveyed 168 cases between 1951 and 1958. The following four groups can be identified:

1. The *septic form*, occurring mostly during the first three months of life. This has a poor prognosis, often leading to death within a few days. It is characterized by interstitial edema and extensive exudative reaction of the pleura, resulting in empyema.
2. The *predominantly abscess-forming group*, producing abscesses ranging in size from a pinpoint to a hazelnut. The x-ray film shows infiltrations in the lung field which are gradually being resorbed, leaving pseudocysts. Pleural effusion is often present.
3. The *interstitial type*, which has a more favorable prognosis, usually not leading to liquefaction. The x-ray film shows streaky interstitial densities and hilar enlargement.
4. The *cystic-emphysematous* form, showing multiple emphysematous air cysts, which develop either primarily or following an abscess. They have a thin margin and an exudate is seldom seen.

The author has noticed that during the last years the antibiotics have gradually lost their efficacy, causing prolongation of the disease and an increase in the complications.

The virus pneumonia of children starts with an edematous stage, with the production of veil-like (frosted glass) densities in the upper portions of the lungs and in the perihilar area. Later, the edema produces compression of the alveoli and atelectasis with compensatory emphysema.

The so-called "segmental" pneumonia belongs in the group of the lobar pneumonias which have failed to develop fully because under the influence of the antibiotics, the process was arrested before it could extend over the whole lobe.

Another form is the "atypical" pneumonia, or pneumonitis, which is a virus pneumonia in which the pneumonic process mostly travels along the interstitial tissues, causing streaky interstitial densities.

Nineteen roentgenograms; 3 tables.

WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

Eosinophilic Pneumonia. Report of Two Cases with Pulmonary Biopsy. Anthimos J. Christoforidis and William Molnar. J.A.M.A. **173:** 157–161, May 14, 1960. (W. M., 410 W. 10th Ave., Columbus 10, Ohio)

Although eosinophilic pneumonia is generally considered to be a symptom-free condition with incidental pulmonary findings of a few days duration, the symptoms may be severe and the illness may last for weeks or even months. The authors report 2 cases, with persistent fever, marked eosinophilia, and the roentgen demonstration of ill-defined shifting infiltrations in the lungs. An unusual x-ray finding in the first case was hilar lymph-node enlargement. Pulmonary biopsies were performed. In the first case the most striking lesion was an infiltration of lobular septa and of the perivascular adventitia with eosinophils; in the other patient there was a similar infiltration, which formed small masses of the type seen in lobar pneumonia. The first patient recovered promptly after the biopsy. The second responded to treatment with prednisone.

Four roentgenograms; 1 photomicrograph.

WILLIAM MARTEL, M.D.
University of Michigan

Pulmonary Alveolar Proteinosis. Report of Case with Fatal Outcome. Edgar G. Harrison, Jr., Matthew B. Divertie, and Arthur M. Olsen. J.A.M.A. **173:** 327–332, May 28, 1960. (The Mayo Clinic, Rochester, Minn.)

The authors report a case of rapidly fatal pulmonary alveolar proteinosis. This is the ninth death among more than 30 cases of this disease recorded in the literature since 1938, when it was first described. The clinical course of the authors' patient was characterized by a rapid progression of pulmonary insufficiency, with secondary polycythemia and cor pulmonale. There were the usual symptoms associated with the condition, namely, progressive dyspnea, nonproductive cough, fatigue, and fever. The patient also had cyanosis on exertion, which has been an early feature in those who have died of the disease.

At autopsy the lungs were found to be grossly consolidated. Microscopic examination showed the alveoli to be filled with a dense, eosinophilic material, which gave an intensely positive reaction with the acid-Schiff technic. This proteinaceous material was apparently formed by the proliferation, desquamation, and degeneration of alveolar septal cells.

Roentgen examination of the chest revealed bilateral diffuse changes suggestive of pulmonary edema, but compatible with a diffuse inflammatory or fibrotic process. This has been the usual finding in pulmonary alveolar proteinosis. The hilar adenopathy so characteristic of sarcoidosis has not been described. There is usually little correlation between the appearance of successive roentgenograms and the patient's progress. Improvement or worsening of the clinical picture is not infrequently accompanied by paradoxical roentgen changes.

The pathogenesis of pulmonary alveolar proteinosis is discussed, including the possible relationship of this disease and Pneumocystis pneumonitis.

One roentgenogram; 4 photomicrographs; 1 photograph.

HAROLD A. SWANSON, M.D.
Calgary General Hospital, Calgary, Alta.

Sarcoidosis. Experience at a Naval Hospital. C. Charles Welch and Robert O. Canada. Am. Rev. Resp. Dis. **81:** 271–274, February 1960. (C. C. W., U. S. Naval Hospital, Great Lakes, Ill.)

A diagnosis of sarcoidosis should be considered in every patient presenting with hilar adenopathy; if there is associated infiltration in the parenchyma of the lung, the possibility is strengthened. The authors reviewed the records of 59 patients with sarcoidosis admitted to a naval hospital between 1947 and 1958. Sixty-three per cent of these cases were discovered by routine roentgenography of the chest. Most of the patients were asymptomatic at the time of admission. Mediastinal adenopathy was demonstrated roentgenographically in 88 per cent, and parenchymal infiltration of the lungs in 54 per cent. Scalene lymph-node biopsy was positive for sarcoidosis in 72 per cent of the 50 patients so examined. Only 6 of the 59 patients required discharge from the Service because of physical disability resulting from sarcoidosis. Except for one fatality, due to sarcoid involvement of the brain, there was no case which showed progression of the disease during the period of observation.

In the latter part of the study period, adrenal corticoids were used to treat those patients who had more than minimal infiltration of the lungs. The period of treatment was six to eight weeks and, if the tuberculin skin test was positive, concomitant antituberculous chemotherapy was administered prophylactically. It was the clinical impression that the patients receiving adrenal corticoids exhibited more rapid resolution of the parenchymal lung disease than those untreated.

Two roentgenograms; 2 tables.

JOHN H. JUHL, M.D.
University of Wisconsin

Pulmonary Aspergillosis. Angelo Toigo. Am. Rev. Resp. Dis. **81:** 392–396, March 1960. (2112 S. 24th Ave., Broadview, Ill.)

Only a few species of *Aspergillus* produce disease in man. Such infections are encountered, in the main, in persons who have received antimicrobial or adrenal steroid hormone therapy for other diseases and those who are employed in farming or grain handling. The roentgen manifestations of pulmonary *Aspergillus* infection vary widely; the infiltrate may resemble acute lobar pneumonia, bilateral bronchopneumonia, solitary lung abscess, and intrabronchial mycetoma or fungous ball. Occasionally the disease pattern may imitate pulmonary tuberculosis; solitary masses may simulate bronchogenic carcinoma.

The author reports a case of pulmonary aspergillosis in which massive hemorrhage led to death, and the diagnosis was confirmed at autopsy. When the patient was admitted to the hospital, roentgen examination showed extensive involvement of the left lower lobe, consisting of poorly defined nodules and areas of conglomerate infiltrate. Despite the fact that the condition improved clinically, a roentgenogram taken eleven days after admission revealed wide dissemination of infiltrations, especially to the upper lobes of both lungs. A film taken two weeks later disclosed some

clearing of the infiltrates in the left lower lung, but numerous cavities had developed in the upper parts of both lungs. The patient died two days later of massive pulmonary hemorrhage.

Autopsy failed to reveal the source of the hemorrhage. Examination of the lungs showed numerous thick-walled abscess cavities with a heavy growth of fungus in their walls. *Aspergillus niger* grew in pure culture from this material. There was a diffuse bronchopneumonia, chiefly in the upper lobes. There was no evidence of *Aspergillus* infection in other organs.

Four roentgenograms; 2 photomicrographs.

JOHN H. JUHL, M.D.
University of Wisconsin

Pleuropulmonary Amebiasis. A Review with an Analysis of Ten Cases. B. H. Webster. Am. Rev. Resp. Dis. **81:** 683–688, May 1960. (228 Doctors Bldg., Nashville 3, Tenn.)

Pleuropulmonary involvement ranks second in frequency to hepatic involvement as a complication of amebiasis. Lesions in the liver and lungs are believed always to be secondary to intestinal infestation, but the mode of spread varies. Ochsner and De Bakey (J. Thoracic Surg. **5:** 225, 1936) analyzed 153 cases of pulmonary amebiasis collected from the literature and found that 14.3 per cent of the patients had hematogenous pulmonary abscess without liver involvement; 10.4 per cent had hematogenous pulmonary abscess and independent liver disease; 37.2 per cent had pulmonary abscess extending from a liver abscess; 19.6 per cent had bronchopulmonary fistulas with little pulmonary involvement;. and 17.6 per cent had empyema extending from a liver abscess.

The findings in 10 cases of pleuropulmonary amebiasis, observed in a series of 249 cases of amebiasis, are reported. None of the 10 patients had ever been outside the continental United States; only 4 had had frank dysentery. The symptoms were variable. All 10 patients complained of cough. A cough productive of a copious "chocolate-sauce" pus is thought to indicate a communication between a liver abscess and a bronchus. This type of sputum is generally accepted as virtually diagnostic of pulmonary amebiasis. Pain in the right thorax was encountered in 8 cases. All patients had fever at some time during the course of their illness. Other symptoms included wheezing, hemoptysis, hoarseness, chills, and gagging.

The roentgen findings in pulmonary amebiasis are not diagnostic. A triangular pneumonic shadow with or without a lung abscess above the diaphragm is often found. Ochsner and DeBakey state that the shadow is characteristically triangular-shaped, with the base below and the apex extending toward the hilus above. Elevation and fixation of the right diaphragm were noted in 7 of the 10 patients in the present series; 6 had an infiltration at the right pulmonary base, and 6 had enlargement of the right hilar shadow. Pleural fluid is common.

Pleuropulmonary amebiasis must be differentiated from nonspecific lung abscess and pleural effusion, as well as bronchopneumonia, bronchiectasis, and basilar tuberculosis. Subphrenic abscess may be difficult to rule out because of elevation of the right diaphragm. The diagnoses in the present series were confirmed by the demonstration of *Endamoeba histolytica* in the form of trophozoites in 9 cases and as cysts in 1.

All of the patients responded promptly to specific medication and surgery proved unnecessary, despite the fact that in 8 cases a bronchobiliary communication existed.

Four tables.

JOHN H. JUHL, M.D.
University of Wisconsin

X-ray Diagnosis of Hydatid Cyst of the Lung: Its Rupture into the Bronchus and Spontaneous Healing. R. Venkateswara Rao. J. Indian M. J. **34:** 353–355, May 1, 1960. (Gandhi Medical College, Secunderabad, Hyderabad, India)

A case of hydatid cyst in an 18-year-old male is reported. In 1956 a rib resection and drainage had been done for hydropneumothorax of doubtful etiology. In March 1959, when the patient again complained of chest pain, a plain roentgenogram showed, in addition to organized pleurisy, evidence of an old pyothorax and two coin lesions in the left lung in the second and fourth segments. Multiple cysts were seen in the first left segment. The lesion in the second left segment was of homogeneous opacity and measured 3 inches, that in the fourth left segment was smaller, roughly 1 1/4 inches in diameter. On deep expiration there was a change in shape of the two lesions, proving that they were cystic in nature.

Within a fortnight the patient experienced symptoms of cough, foul-smelling, thin, slightly yellowish expectoration, and a rise in temperature. Roentgen studies demonstrated a thick-walled cavity in the second left segment 2 1/2 inches in diameter, replacing the earlier coin lesion, and another thin-walled cavity 1 inch in diameter, with fluid level, in the same segment and at a lower level, with surrounding pneumonitis. The second coin lesion in the fourth segment could still be visualized. The diagnosis of a hydatid cyst rupturing into a bronchus and producing the double cavity sign was made. This was confirmed by the later demonstration of scolices in the sputum. A negative Casoni test is explained by gradual desensitization by the inseminated hydatid fluid following rupture of the cyst.

Roentgenograms on April 4 showed that the cavity with fluid changed position with posture, and on April 18 the resolution of the ruptured cyst was demonstrated, with disappearance of the cavernous lesions, suggesting spontaneous recovery.

There are several points of interest in this case: (1) The demonstration of multiple cysts suggests that the patient may have had hydatid cysts previously which may have ruptured, or the multiple cysts may be the evidence of compensatory emphysematous bullae which could be differentiated only histopathologically. (2) The thin-walled cavity with fluid level was outside the large thick-walled cavity instead of inside. This gives the impression that the endocyst was of exogenous origin from the germinal layer of the mother cyst or, if it were of endogenous origin, that it had emerged from the pericyst through the rent which communicated with the bronchus. (3) The cyst was located in the upper zone, in contrast to the usual localization in the lower zone.

Roentgen Changes in the Thorax in Periarteritis Nodosa. K.-H. Vogel and E. Flink. Fortschr. a. d. Geb. d. Röntgenstrahlen **92:** 501–507, May 1960. (In German) (Med. Strahleninstitut der Universität Tübingen, Germany)

Changes in the lungs occur in about 25 to 30 per cent of cases of periarteritis nodosa. While it was formerly

thought that the findings on the chest film were due to secondary infections, terminal pneumonic processes, etc., it is now generally recognized that the disease itself may produce certain, although not very characteristic, shadows on the roentgenogram. The bronchial arteries as well as the pulmonary arteries may be involved. If the bronchial arteries are mainly affected, a severe bronchitis may result, with a stubborn cough, pain in the chest, and hemoptysis.

The roentgen changes are not typical. They may be bizarre and transient. They may progress in one part of the lung and at the same time recede in another. If a larger artery is involved, small spots seem to appear first. These may later become confluent and form irregularly defined densities, mostly in the central regions near the hili. Later, infarction, necrosis, and cavitation may occur. Effusions within the pleura have been reported (Doub, Goodrich, and Gish: Am. J. Roentgenol. **71**: 785, 1954. Abst. in Radiology **64**: 445, 1955).

The differential diagnosis may be quite difficult or impossible. The following diseases should be considered: "hypersensitivity angiitis," congestive changes, pneumoconiosis, silicosis, Boeck's sarcoid, carcinoma, Hodgkin's disease, tuberculosis, parasitic diseases.

The author describes 2 proved cases of periarteritis nodosa with cavitation.

Eight roentgenograms.

WILLIAM A MARSHALL, M.D.
Chicago, Ill.

Roentgen Findings in the Thorax in the Chronic Leukoses. H. Hartweg. Fortschr. a. d. Geb. d. Röntgenstrahlen **92**: 477–490, May 1960. (In German) (Med. Strahleninstitut der Universität Tübingen, Germany)

Pathological changes demonstrable on the chest film occur quite frequently in the chronic leukemias. There may be leukemic infiltrations in the perivascular and peribronchial spaces or in the alveoli themselves. There may be changes in the lungs due to chemotherapeutic substances or the result of inflammatory processes that have not been properly controlled on account of the altered function of the leukocytes. The picture is further complicated by infarction due to leukemic thrombi, by lymphatic congestion caused by enlarged nodes, and by pleural effusion.

The author reports the findings in 137 cases of chronic leukoses, of which 62 were myeloses and 75 lymphadenoses. Roentgenologically demonstrable changes in the thorax occurred in 77, *i.e.*, 56 per cent. Besides, there were 6 cases of elevation of the diaphragm due to leukemic involvement of the spleen and liver. The changes are classified as follows: (1) miliary or submiliary foci; (2) streaky infiltrations; (3) bronchopneumonic or lobar pneumonic infiltrations; (4) mediastinal tumors and hilus tumors. Mixed forms also occur.

Enlarged lymph nodes were seen more often in the lymphadenoses than in the myeloses. They are mostly in the hili and are usually bilateral. For the most part, they regress promptly after x-ray treatment.

Pleural effusion may be caused by leukemic involvement of the pleura itself, by congestion due to blockage of the lymph channels, or by inflammatory processes that remain unchecked on account of the diminished resistance of the patient. Effusions occurred in 22 per cent of the author's cases.

Of the lung changes, interstitial infiltrations were most frequent (over half of the cases). They may produce a streaky or reticular pattern. Miliary foci were also observed. The so-called Kerley B-lines, horizontal lines in the lower lungs, about 1 to 3 cm. long and 1 to 2 mm. thick, which are thought to be due to lymphatic congestion, were seen. A pneumonic type of involvement is also quite frequent. It may resemble bronchopneumonia or a lobar pneumonia. One case is cited which showed patchy infiltrations scattered over both lungs, closely resembling tumor metastases. The author believes that in the leukoses there may be a hematogenous dissemination of the cells which then go on to autonomous growth, like any other malignant tumor.

Twenty roentgenograms; 1 photograph.

WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

Objective Diagnostic Routine for Pulmonary Emphysema. W. Schröder. Fortschr. a. d. Geb. d. Röntgenstrahlen **92**: 491–500, May 1960. (In German) (R. K. Krankenhaus, Osterstrasse 1, Bremen, Germany)

Only three objective radiological signs of emphysema have been generally accepted: diminution of the height of the diaphragm, restriction of respiratory diaphragmatic movements, and increase in the costodiaphragmatic angle. These signs may be determined from a plain postero-anterior film and by fluoroscopy. The height of the diaphragm is obtained by measuring the vertical distance between the highest point of the diaphragm and a horizontal line going through the lowest point of the pleural sinus. The costodiaphragmatic angle is formed by a vertical line in the pleural sinus and a line tangential to the diaphragm. The respiratory movements of the diaphragm are measured in relation to the width of the intercostal space. Normally, the movements amount to more than the width of the space. If they are reduced to half the width, a severe emphysema exists and the residual volume of the lungs has been increased by more than 50 per cent.

The author thinks that a great deal of additional information may be obtained by other radiological procedures. A kymographic examination of the diaphragm during a single heavy cough will show the maximal amplitude of the diaphragmatic movements. In emphysema this amplitude is definitely diminished and the peak is altered. A lateral view of the thorax will show irregular attachments of the diaphragm, pleural adhesions, localized relaxations, deformities of the thorax, etc.

The presence of increased transparency of the lung on a single film is subject to individual interpretation. It is a sure sign of emphysema only if it is associated with a diminution in the change of radiotranslucency between inspiration and expiration. A great deal of the uncertainty can be eliminated by taking films by high-voltage technic. The author recommends two lateral views of the thorax at 115 to 125 kv. One is taken in maximal inspiration and one in maximal expiration. The difference between the two films in a healthy person is quite striking; one can barely identify any detail on the film taken in expiration. In emphysema of the first degree (residual air 30 to 40 per cent of total capacity) the retrocardiac space is vaguely recognizable; in the second degree (residual air 40 to 50 per cent of total capacity), the film taken in expiration plainly shows the retrocardiac space and the posterior outline of the heart; in the third degree (residual air over 50 per cent of total

capacity) there is hardly any difference between the two films.

The author also recommends a plain postero-anterior view with high-voltage technic to demonstrate a localized emphysema. He feels that in the usual low-voltage film the fine lung structure is often lost in the dark air spaces of the emphysema, while the high-voltage technic with its greatly diminished contrast will allow the visualization of fine septa, fibrotic streaks, and the stroma of the lungs.

Thirteen roentgenograms; 3 kymograms.

WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

Hypertransradiancy of One Lung Field and Its Experimental Production by Unilateral Miliary Embolisation of Pulmonary Arteries in Cats. R. F. Fouché and J. L. D'Silva. Clin. Radiol. (J. Fac. Radiologists) **11:** 100-105, April 1960. (The London Hospital, London, England)

Hypertransradiancy of one lung field, as seen on the chest roentgenogram, may occasionally be due to congenital abnormalities, but in the majority of cases it is probably associated with acquired lung disease. At least some instances of unilateral hypertransradiancy of the lung fields are in fact cases of unilateral pulmonary emphysema. The basis of the abnormal x-ray appearance is the narrowing of vascular markings throughout the whole or greater part of one lung field. A less striking finding is apparent widening of the vascular shadows on the nonaffected side. The most useful procedures for diagnosis are whole lung tomography and fluoroscopy.

An important histologic feature of emphysema is the breakdown and distortion of respiratory tissue, with consequent destruction of pulmonary capillaries and deformation of arterioles; these changes lead to an increase in the resistance to blood flow through the affected lung. After pneumonectomy the main pulmonary artery pressure is practically unchanged in spite of the removal of half of the pulmonary vascular bed. Therefore, in unilateral emphysema, even if the majority of capillaries were obliterated in the diseased lung, no appreciable increase in the main pulmonary artery pressure would be expected. The peripheral resistance being increased in the emphysematous lung, the blood flow through it will be reduced, whereas the normal lung will adapt to the increased pulmonary flow by a reduction in its vascular resistance. In this way total flow will be maintained.

In order to study the effect of increasing the peripheral resistance in one lung, unilateral miliary embolization of the pulmonary artery was produced in cats by injection of starch granules into the right jugular vein during occlusion of the left pulmonary artery. Pulmonary arteriograms were then taken at various intervals up to three hours. In 10 animals, progressive arterial narrowing on the embolized side was demonstrated, with attainment of maximum reduction in from thirty to one hundred and twenty minutes. Postmortem arteriograms showed equal filling bilaterally, suggesting that the narrowing of the vessels was due to vasospasm and that no gross obstruction of larger arteries with starch had occurred (this was confirmed histologically).

These experiments thus support the view, but do not prove, that the narrowed pulmonary vessels in unilateral emphysema are the direct consequence of the reduction of the peripheral vascular bed produced by the disease process itself. The well known narrowing of the distal, and widening of the proximal, segments of pulmonary arteries seen in chest roentgenograms in certain cases of bilateral emphysema and mitral stenosis may be explained by the same hypothesis. In some cases of mitral stenosis the raised left atrial pressure alters the pressure gradient in the entire pulmonary arterial tree so that the rise in pressure in the lung capillaries is proportionately much greater than the rise in pressure in the large vessels; this could lead to vasoconstriction throughout the lungs and to an increase in the pulmonary artery pressure. Since there must be some limit to this constricting force, the limit would be expected to be low in the larger, predominantly elastic arteries. Hence it is not surprising that dilatation of the proximal pulmonary arteries occurs even though the smaller muscular branches remain constricted. Thus, a generalized emphysema may affect predominantly the lung bases, giving the appearance of narrowed basal vessels with normal or even widened apical vascular shadows. It has been suggested that a similar picture in mitral stenosis may be due to just such a redistribution of blood flow.

Five roentgenograms; 1 diagram.

SAMUEL B. HAVESON, M.D.
Lynwood, Calif.

Gamma Globulin Concentrations in Ambulatory Patients with Bronchiectasis. A Survey with Report of One Case of Agammaglobulinemia Treated for Four Years. Helen S. Pittman. Am. Rev. Resp. Dis. **81:** 251–255, February 1960. (Massachusetts General Hospital, Boston 14, Mass.)

The gamma globulin concentrations in 52 ambulatory patients with true bronchiectasis were studied to determine the extent of gamma globulin deficiency in this condition. Some patients had mild, others advanced disease. Gamma globulin concentrations were obtained in 50 patients and isohemagglutinins in 43. Not a single instance of a deficiency of gamma globulin was encountered. It is therefore evident that agammaglobulinemia is not very frequently the basic defect in bronchiectasis.

At the time of this study, one patient in the hospital was found to have severe hypogammaglobulinemia. She had had repeated episodes of pulmonary infections and had persistent atelectasis of the left lower lobe, and was thought to have bronchiectasis. She was treated with gamma globulin and, during the four years she has been receiving this therapy, has had no further episodes of pneumonia.

Three tables.

JOHN H. JUHL, M.D.
University of Wisconsin

THE HEART AND BLOOD VESSELS

A New Radiologic Sign of Myocardial Infarct. L. di Guglielmo and A. Trenta. Radiol. med. (Milan) **46:** 113–120, February 1960. (In Italian) (Istituto di Radiologia di Pavia, Italy)

Since the diagnosis of early myocardial infarct offers many difficulties and since in some cases the electrocardiographic findings are not of decisive value, the authors contribute a new radiologic sign based on the observation of 18 patients who were examined in various phases of infarction. The sign described consists of an indentation of the left ventricle low on the esophagus best seen in the lateral position. This is due to en-

largement of the inflow tract of the ventricle without significant enlargement of its outflow tract.

Differentiation of the impression of the left ventricle on the esophagus from that of the left atrium is based on the position of the imprint, that of the atrium being higher up.

The sign described has its greatest value in infarcts of the anterior surface of the heart and the anterior portion of the interventricular septum. Among 18 cases studied, the sign of enlargement limited to the inflow tract of the left ventricle was definite in 12; in 2 there was enlargement also of other chambers of the heart; in 4 the sign was absent.

Six illustrations.

ALEXANDER R. MARGULIS, M.D.
Washington University School of Medicine

Kinking of the Aortic Arch Associated with Fusiform Aneurysmal Dilation. A. F. Barrett and G. I. Verney. Clin. Radiol. (J. Fac. Radiologists) **11:** 106–109, April 1960. (Royal Victoria Infirmary, Newcastle upon Tyne, England)

Kinking or buckling of the aortic arch may be confused radiologically with tumor of the superior mediastinum, lymphadenopathy, saccular aortic aneurysm, or coarctation of the aorta. The aorta ascends to form a high arch and then descends to the site of the ligamentum arteriosum. Here the kink occurs, and the aorta then resumes its downward course. Although elongation of the aorta and an abnormally short ductus have been thought to play a part in the development of this abnormality, its rarity suggests that it is a congenital and not an acquired deformity. It has been described in a twelve-year-old child (Stevens: Radiology **70:** 67, 1958).

Two cases of kinking of the aortic arch in elderly males are reported. In each case, a postero-anterior chest radiograph showed the double contour of the aortic knuckle, and a left lateral projection revealed kinking of the aorta at the site of the ligamentum arteriosum. Left lateral tomograms demonstrated a uniformly dilated descending aorta in each instance, thus excluding the possibility of saccular aneurysm. In neither case were there clinical findings of significance related to the positive radiographic changes.

Six roentgenograms.

SAMUEL B. HAVESON, M.D.
Lynwood, Calif.

Supravalvular Aortic Stenosis with Hypoplasia of the Aorta. M. Herbst, K. Bock, O. Hartleb,and H. Fiehring. Fortschr. a. d. Geb. d. Röntgenstrahlen **92:** 533–542, May 1960. (In German) (Karl-Marx Universität, Chirurgische Klinik, Leipzig, Germany)

Supravalvular stenosis of the aorta is extremely rare. Its differentiation from subvalvular stenosis assumes importance since the latter can be cured by operation while supravalvular stenosis has not yet been surgically corrected.

In supravalvular stenosis there is usually an elastic band passing transversely across the lumen of the aorta above the valve. Often it is associated with a hypoplasia of the entire aorta, as well as the other large vessels. The diminished lumen of the aorta puts an excessive burden upon the left heart, which causes a protrusion of the ventricular septum to the right. This may lead to a functional stenosis of the right outflow tract, so that congestion of the lungs, which otherwise would develop, does not occur. This condition is usually called the Bernheim syndrome.

Usually supravalvular stenosis is found at operation or diagnosed postmortem. Clinically the blood pressure and findings on auscultation are not diagnostic. The chest leads in the electrocardiogram may give a clue, inasmuch as the QRS complexes of V4, V5, V6, and V7 are often inverted. The absence of the aortic knob on the x-ray film and the narrowing of the aorta strengthen the suspicion, but it is only the isolated demonstration of the left heart by injection of contrast material directly into the left ventricle that clinches the diagnosis by demonstrating the lesion.

Eighteen cases are described in the literature. Two cases are reported here. The condition is congenital, but the exact mechanism of its development is not known.

Seven roentgenograms.

WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

Disco-Vertebral Necrosis After Aortography. M. Demoulin. J. belge de radiol. **43:** 186–190, 1960. (In French) (Hôpital de Seraing, Belgium)

Four cases are reported in which necrosis of an intervertebral disk and two adjacent vertebrae followed aortography. This is a serious and a rather unusual complication of the procedure. A tri-iodo compound was used in these cases. The accident had not been observed when di-iodo compounds were being employed.

The clinical symptoms extended over a period of about six months, beginning almost immediately after aortography. There was low-back pain and fever, the pain usually lasting much longer. The radiologic findings usually appeared two or three months later. The findings included flattening of the disk and cortical destruction of the adjacent vertebral bodies, with ultimate osteogenic reaction and osteophytic bridging.

CHARLES M. NICE, JR., M.D., PH.D.
Tulane University

Correlation of Radiographic Findings with Clinical Features of Degenerative Arterial Disease. G. D. Tracy, James Kalokerinos, and F. Harrison. M. J. Australia **1:** 842–844, May 28, 1960. (Royal North Shore Hospital, Sydney, Australia)

Arteriography has been performed by the authors in 72 patients with occlusive arterial disease; both legs were examined in 32, for a total of 104 limbs. All but 7 of the patients were males, with an average age of sixty-four years. The arteriographic studies were designed to demonstrate the main limb vessels as far as the lower end of the popliteal artery, as no direct surgical procedures were contemplated on vessels of smaller diameter than the popliteal. In all of the patients with symptoms of arterial insufficiency in the limbs, arteriography showed obstructions in the main arterial trunks proximal to the end of the popliteal artery.

Thirteen patients had occlusions of the terminal portion of the aorta and/or the iliac arteries. Pain at rest and gangrene are rare in obstructions at this level, and surprisingly the prognosis for these high obstructions is remarkably good. In those patients in whom replacement or by-pass graft procedures are being considered, arteriographic visualization of the distal arteries is considered essential.

The femoral artery was by far the most common site of occlusion—83 of the 104 limbs studied (80 per cent). A striking feature was the constant involvement of the

distal part of the femoral artery where it passes through the adductor hiatus (Hunter's canal). Symptoms were variable, but claudication was almost always confined to the muscles of the calf. Arteriographic findings were of no value in determining either the severity of the ischemia or the level of amputation in the presence of gangrene.

Occlusion of the popliteal artery had occurred in only 8 limbs. Claudication was found in the calf and small muscles of the foot but is not as common as in femoral artery occlusion. There is a high incidence of pain at rest and gangrene in these distal occlusions.

The demonstration of calcification within the vessel walls by plain roentgenograms is a frequent and helpful finding in occlusive arterial disease. Calcification of the media (Mönckeberg) is regular, diffuse, and fine-grained, with a distinct tendency to accumulation in rings. No patient in the present series exhibited this type of calcification. Intimal calcifications occur in irregular, discrete plaques, frequently confined to an occluded segment. Such calcification was demonstrated in about 50 per cent of the roentgenograms; it precludes thrombo-endarterectomy.

Plain radiography is more valuable than arteriography in the diagnosis of aortic aneurysm. The presence of laminated thrombus lining the aneurysmal wall frequently gives a comparatively normal arteriographic appearance.

It is emphasized that clinical assessment is more valuable than arteriography in determining the prognosis and assessing the level of amputation in gangrene.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Arteriography in the Diagnosis of Dissecting Aneurysm. David Sutton. Clin. Radiol. (J. Fac. Radiologists) **11**: 85–92, April 1960. (St. Mary's Hospital, London, W. 2, England)

Dissecting aneurysms may be of the classical type, originating in the ascending aorta or aortic arch, or of the peripheral type, forming in all grades of arteries down to the small perforating branches in the brain. The author reports 6 cases, 1 of local dissecting aneurysm of an iliac artery, 1 of local dissecting aneurysm of the lower abdominal aorta, and 4 of the classical type.

Classical Dissecting Aneurysms: In most cases of spontaneous dissecting aneurysm, the dissection commences in the region of the aortic arch and spreads rapidly, splitting the aortic wall into two parts. The aneurysm may extend backward to involve the heart and coronary vessels and may rupture into the pericardium. Hypertension is present in the majority of cases, and the heart is often enlarged. In the classical case the patient is seized by a sudden severe pain in the chest. Other physical signs depend largely on the major arterial branches involved in the dissection. Some 80 per cent of the patients die within four days of onset of acute dissection; if death does not occur within the first two weeks, further prognosis is relatively good. A so-called chronic dissecting aneurysm results in approximately 10 per cent of cases (Drury: Brit. M. J. 2: 1114, 1955). One of the author's cases was of this type. An atheromatous abdominal aneurysm was suspected, but translumbar aortography revealed a false aortic lumen (entered by the needle) and a compressed true aortic lumen; the diagnosis was confirmed by percutaneous retrograde aortography.

While the diagnosis of dissecting aneurysm may sometimes be made clinically, it will be missed in an appreciable proportion of cases. Simple chest roentgenograms can be of much assistance, particularly if comparison with previous films discloses a recent marked widening and unfolding of the aorta. Less commonly seen, but highly suggestive of the diagnosis, is a marked widening of the aortic knuckle with an exceptionally wide gap between a calcified intima and the outer aortic border. Since the quality of films on these very ill patients is often poor, even these radiologic signs must be interpreted with caution.

Percutaneous retrograde aortography was employed by the author in 6 cases of suspected acute dissection. In 3 of these, the diagnosis was confirmed absolutely, and the lower limits of the dissection were demonstrated for surgical intervention. In the other 3, the suspected diagnosis was refuted; this proved as valuable in the treatment of these patients as a positive confirmation of the presence of a dissecting aneurysm. Coronary occlusion, arterial embolism, ruptured abdominal aneurysm, and other acute abdominal conditions such as acute pancreatitis and mesenteric thrombosis, have all been mistakenly diagnosed as dissecting aneurysm. Cerebrovascular accidents, transverse myelitis, pulmonary embolism, and spontaneous pneumothorax have also given rise to erroneous clinical diagnoses of dissecting aneurysm.

Formerly, treatment was essentially medical and palliative. The high morbidity of dissecting aneurysm has led in recent years to an increasing number of attempts at surgical therapy. At the author's hospital, 7 cases have been operated on in the last five years (Rob and Kenyon).

Peripheral Dissecting Aneurysms: The literature on peripheral dissecting aneurysms is not very extensive. The condition is probably commoner than is realized and, once attention is drawn to it, the number of recorded cases will increase rapidly. The author has seen 2 cases, which he reports. In the case of local dissecting aneurysm of an iliac artery, percutaneous retrograde femoral catheterization was performed. The aortographic appearance was diagnostic since both the true and false lumens were outlined. In the case of local dissecting aneurysm of the lower abdominal aorta, lumbar aortography showed an unusual irregular narrowing of the abdominal aorta below the renal arteries. It was thought that this was probably an atheromatous stenosis. The apparent "thrombus" removed at surgery proved to be an organized dissecting aneurysm

Thirteen roentgenograms.

SAMUEL B. HAVESON, M.D.
Lynwood, Calif.

Idiopathic Dilatation of the Pulmonary Artery. Madhukar Deshmukh, Sulahattin Guvenc, Lamberto Bentivoglio, and Harry Goldberg. Circulation **21**: 710–716, May (Part I) 1960. (Hahnemann Medical College, Philadelphia, Penna.)

Differentiation of idiopathic dilatation of the pulmonary artery from other congenital and acquired lesions with dilatation is of primary importance because most of the latter abnormalities can be corrected by surgical procedures. Idiopathic dilatation of the pulmonary artery is, on the other hand, a benign anomaly and does not appreciably affect cardiac function.

The clinical, roentgenologic, electrocardiographic, and hemodynamic features of 13 cases of idiopathic

dilatation of the pulmonary artery are described. Absence or mildness of symptoms was the most significant finding in this series. A pulmonary systolic murmur was constantly present. Roentgen examination showed a normal cardiac silhouette and, in striking contrast, dilatation and prominence of the pulmonary artery segment in postero-anterior and right anterior oblique views. The paradox of an enlarged main pulmonary artery and diminished vascularity of the periphery of the lung fields, so characteristic of pulmonary stenosis, was absent in this condition. The hyperemic lung fields and the hilar dance, which are common in large left-to-right shunts, were also lacking. Electrocardiograms were normal. The hemodynamic studies revealed a mild systolic pressure gradient across the pulmonary valve in some cases in the presence of normal right ventricular pressure.

Six roentgenograms; 2 tracings; 2 tables.

ZAC F. ENDRESS, M.D.
Bloomfield Hills, Mich.

Mesenteric Vascular Disease. C. C. Wang and John D. Reeves. Am. J. Roentgenol. **83:** 895–908, May 1960. (Massachusetts General Hospital, Boston 14, Mass.)

The mesenteric arteries are subject to the same atheromatous, thrombotic, and embolic phenomena as the coronary and cerebral vessels. Since the principal visceral organ supplied by the mesenteric arteries is the bowel, considerable information may be gained from study of plain roentgenograms of the abdomen, barium meal and enema examinations, as well as from contrast visualization of the aorta and its branches. It was formerly thought that mesenteric artery abnormalities exhibited a specific pattern; this belief is no longer held. The authors feel, however, that certain manifestations of mesenteric vascular occlusion have not been adequately stressed.

The etiology of mesenteric occlusion varies. Underlying systemic disease, generalized atherosclerosis, cardiac disease with endocardial vegetations, atrial fibrillation, recent myocardial infarction, and vasculitis play important roles. Blood dyscrasias and cardiac and abdominal surgical procedures may also be responsible. Mesenteric artery occlusion may be either embolic or thrombotic; venous occlusion is always thrombotic.

Pain is usually a feature in the patient with mesenteric vascular disease. In acute occlusion, it is often excruciating, while in chronic occlusion, it is dull. In some patients the pain is related to the ingestion of food, appearing two to four hours after eating and lasting for a similar period. The severity of the pain may be proportional to the quantity of food consumed, presumably a reflection of work overload on the relatively ischemic bowel. Anorexia and nausea are of frequent occurrence. Blood will be present in the stool if the bowel is infarcted.

The prognosis in acute mesenteric occlusion is poor, the mortality ranging from 60 to 85 per cent. In subacute and chronic cases the outlook is uncertain, since the disease may not always be recognized.

When the arterial blood supply to the bowel is cut off completely by either thrombi or emboli, the result in the intestine is infarction. If the occlusion is incomplete, the digestive processes and absorption may be diminished. If the bowel becomes sufficiently ischemic, the bacteria normally present may set up an inflammatory reaction.

In cases of arterial insufficiency with "mesenteric angina" there may be little or no change on plain films or barium studies. Extensive infarction, likewise, may or may not produce gaseous distention of the bowel. When it does, the distended bowel does not usually follow the involved anatomic vascular pattern. In the authors' experience, the findings in arterial and venous occlusion are quite similar, *i.e.*, nonspecific ileus. The "classic" pattern is gas-dilated small and large bowel to the region of the splenic flexure. There may be signs of fixation of a loop or loops of bowel, with edema of the intestinal walls and progressive increase of intraperitoneal fluid. In early cases, contrast studies may show marked swelling of the mucosal folds with thickened bowel wall and, occasionally, an intraluminal pseudotumor formation.

In subacute and chronic cases of mesenteric vascular disease, contrast media may outline narrowing of the bowel lumen, with fixation and ulceration, simulating regional ileitis or ulcerative colitis, with or without evidence of malabsorption syndrome.

There is definite evidence that some gastrointestinal malabsorption syndromes are vascular in origin. In these cases barium studies of the small bowel may reveal dilated loops and mucosal thickening, with flocculation and segmentation of the barium column, presenting a deficiency pattern.

The importance of the clinical history is stressed; the roentgen manifestations alone are rarely sufficient to make a specific diagnosis.

Eight illustrative cases are reported, with 18 roentgenograms.

EDWIN F. KOCH, JR., M.D.
Indiana University Medical Center

Findings on Plain Roentgenograms of the Abdomen Associated with Mesenteric Vascular Occlusion with a Possible New Sign of Mesenteric Venous Thrombosis. Sidney W. Nelson and William Eggleston. Am. J. Roentgenol. **83:** 886–894, May 1960. (Ohio State University Health Center, Columbus 10, Ohio)

Although mesenteric vascular occlusion has been recognized as a clinical entity for more than a century, considerable difficulty is still experienced in diagnosing this disease. Frimann-Dahl (Am. J. Roentgenol. **64:** 610, 1950. Abst. in Radiology **57:** 457, 1951) called attention to the "pseudotumor" sign due to the water-density mass seen on plain roentgenograms of the abdomen, apparently caused by the marked amount of fluid in the infarcted lumen. Others have mentioned the roentgen manifestations of ileus, the extent of which corresponds to the distribution of the occluded mesenteric vessel. The present authors describe an additional observation on plain roentgenograms of the "acute abdomen". The finding of a rigid, edematous segment of bowel, with a small, unspectacular collection of gas remaining in a narrow, relatively straight or curvilinear lumen, without change in distribution in upright or decubitus projections, is suggestive of mesenteric venous obstruction.

A brief summary of the etiology, pathophysiology, and clinical findings is given. It is emphasized that the radiologist must be aware of the entity, and of the suggestive roentgenologic criteria, in order that he may properly evaluate the possibility of mesenteric vascular occlusion in acute abdominal conditions, particularly in the elderly or cardiac patient.

Five roentgenograms; 8 diagrams.

RICHARD L. JONTZ, M.D.
Indiana University Medical Center

An Experimental Study of the Diagnosis of Mesenteric Infarction. Karel E. Absolon, Sister Victorine Long, and Samuel W. Hunter. Surg., Gynec. & Obst. **110:** 617–621, May 1960. (University of Minnesota Medical School, Minneapolis 14, Minn.)

The diagnostic dilemma in mesenteric infarction is discussed, and the therapeutic implications of improved diagnosis are emphasized. The early diagnosis of acute mesenteric occlusion affords an opportunity for corrective vascular surgery, whereas late diagnosis at best permits only bowel resection. The authors have investigated the possibility of using radioactivity determinations over the abdomen as an index of mesenteric vascularity. Their experiments were carried out in dogs, which were divided into four groups: 9 control animals on which a sham operation had been performed; 4 dogs in which the mesenteric artery was ligated; 4 dogs in which the mesenteric vein was ligated; 4 dogs in which the mesenteric vein and artery were ligated simultaneously. Two hours postoperatively 5 microcuries of radioactive iodinated serum albumin (RISA) was injected into the vena cava, and the radioactivity over the abdomen was determined. A characteristic initial peak was obtained in the normal animals. In dogs with mesenteric artery ligation, the radioactivity rise was almost as rapid as in the controls, but the initial peak was absent. Ligation of the mesenteric vein resulted in a slower radioactivity rise over the abdomen than in the two previous groups. Curves in the animals with simultaneous mesenteric artery and vein ligation were similar to those in animals with mesenteric vein ligation only.

While such a clear differentiation in the curves may not be obtained in human beings, it is urged that clinical trials of this new technic for the diagnosis of mesenteric infarction be carried out.

Five radioactivity tracings; 1 drawing; 4 tables.

ROBERT BEAROR, M.D.
University of Pennsylvania

Gas Embolization of the Portal Venous System. Noah Susman and Hyman R. Senturia. Am. J. Roentgenol. **83:** 847–850, May 1960. (216 S. Kingshighway, St. Louis 10, Mo.)

The authors report what they believe to be the first recorded case of gas embolization of the portal venous system in an adult. Their patient was an elderly man, in whom mesenteric thrombosis developed. Necrosis and dissolution of the natural barriers allowed the enteric gas to enter either one or many mesenteric veins and to be transported as bubbles which became arrested in the portal radicles. Because there was roentgen evidence of air in the liver, with distended small-bowel loops, a preoperative diagnosis of gallstone ileus was made.

The roentgen picture in gas embolization of the portal venous system is somewhat similar to that of air in the biliary tree. Air in the portal veins is indicative, however, of an altogether different clinical entity, and it is therefore important to attempt to differentiate these two similar branching patterns. Air in the biliary tree is due to a fistulous communication between the intestine and the gallbladder or common duct; gas enters the major radicles and is prevented from entering the finer radicles by the continuous centripetal flow of the secreted bile. In gas embolization of the portal venous system, the bubbles are carried into the finer peripheral venous radicles in the liver by the centrifugal flow of the portal venous blood. The roentgen differential diagnosis therefore rests on the identification of air in the fine peripheral radicles.

In the authors' case, no gas blebs were seen grossly or microscopically in the intestinal wall, but gas bubbles were visualized in the veins draining the same area. There being no source of gas in the intestinal wall, the immediate source of gas in the veins was almost certainly intraluminal gas under increased tension in distended ischemic small-bowel loops.

Another possible source of gas in the portal veins is interstitial gas generated in *Clostridium* and *B. coli* infections. Intramural gas collections due to *Clostridium* infections have been described as small and multifocal. If in such cases a fistulous communication should develop with a vein, only the small focal collection would be available for embolization. In pneumatosis intestinalis, the individual collections of gas are often much larger and probably interconnected.

The possibility also exists that a large focal collection of gas under increased pressure may be generated by gas-forming bacteria in an abscess in an area being drained by the portal venous bed, and that this gas may subsequently enter the portal channels through a break in the endothelium. Extremely soluble gases, however, such as CO_2 and H_2S, could not cause a significant embolus.

On the basis of an experiment in a dog, it is predicted that if sufficient air were injected to fill the entire portal system in a retrograde manner, an acute portal hypertension would be produced. This may be one of the factors which caused significant intraluminal hemorrhage in the case reported, as this finding is more common with venous than with arterial thrombosis.

Three roentgenograms.

JOHN P. FOTOPOULOS, M.D.
Northwestern University Medical School

Techniques of Arteriography. James Kalokerinos and G. D. Tracy. M. J. Australia **1:** 844–847, May 28, 1960. (Royal North Shore Hospital, Sydney, Australia)

According to the authors, it is only recently that arteriography has been widely employed in Australia. They describe three methods of arteriography that have been found effective and satisfactory in their experience, based on 130 examinations, excluding cerebral angiography. Pertinent details for performance of direct percutaneous femoral arteriography, direct translumbar aortography, and percutaneous transfemoral aortography are presented. The difficulties which have been encountered are discussed, with tips for their circumvention.

Three roentgenograms; 2 photographs; 2 diagrams.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

THE DIGESTIVE SYSTEM

Traumatic Transthoracic Diaphragmatic Herniation of the Stomach. Theodore E. Keats. Missouri Med. **57:** 444–446, April 1960. (University of Missouri School of Medicine, Columbia. Mo.)

The author reports 2 examples of traumatic transthoracic diaphragmatic herniation of the stomach, with typical roentgen signs. Roentgenography made the most important contribution to the diagnosis. In the first case, that of a 12-year-old Negro boy admitted to

the University of Missouri Medical Center twelve hours after an automobile accident, roentgen studies showed the markedly distended stomach occupying the major portion of the left hemithorax, displacing the mediastinum to the right. The gas-filled esophagus was similarly displaced. A large air-fluid level was seen in the stomach, and there was a paucity of gas in the bowel. The stomach was decompressed by passage of a nasogastric tube. The pulse rate then decreased and the general condition improved remarkably. The patient was taken to surgery approximately seventeen hours after admission. At thoracotomy a rent about 7 inches in length was found in the dome of the left hemidiaphragm, through which the stomach had herniated. The rupture was repaired without complication.

The second case was that of a 19-year-old white male seen thirteen hours after an automobile collision. Roentgenograms of the chest and abdomen demonstrated herniation of the stomach through the left hemidiaphragm, with compression of the left lung superiorly and displacement of the mediastinum to the right. A moderate accumulation of gas was seen in the colon. A Levine tube was passed into the stomach and a large volume of air with 700 c.c. of dark-brown, guaiac-positive fluid was removed. At surgery a 5-inch rent was found in the left hemidiaphragm, through which the stomach had herniated. The inferior pole of the spleen was lacerated. Splenectomy and repair of the diaphragm were carried out. The patient's hospitalization was prolonged for care of associated fractures, but no complications referable to the diaphragmatic hernia were encountered.

Four roentgenograms.

Calcifying Mucous-Cell Carcinoma of the Stomach. Report of a Case. Mansho T. Khilnani. Am. J. Digest. Dis. **5:** 479–483, May 1960. (Mount Sinai Hospital, New York 29, N. Y.)

What is believed to be the twelfth case of diffuse calcifying mucous-cell carcinoma of the stomach to be recorded in the literature is reported in a 63-year-old male. The findings permitting correct diagnosis were clearly indicated on a simple film of the abdomen, which showed innumerable calcifications in the left upper quadrant in the region of the stomach. These calcifications measured 1 to 3 mm. in diameter and were seen to follow the contour of the gastric wall, *i.e.*, to be within the wall, which appeared greatly thickened. The mucosal folds, outlined by gas within the stomach, seemed irregular and nodular. These findings suggested the diagnosis of calcifying carcinoma of the stomach. A gastrointestinal series demonstrated irregular contours and destruction and ulceration of the gastric mucosa characteristic of a malignant neoplasm, with calcifications predominantly in the posterior wall and along the greater curvature, but with a few deposits also on the lesser curvature. The gastric wall was about 4 cm. thick. The gastroscope could not be advanced more than an inch beyond the cardia, but a clear tangential view of the corpus suggested "diffuse scirrhous carcinoma of the stomach."

At laparotomy a huge carcinoma involving practically the entire stomach and adherent to all surrounding structures was seen. Metastases to the omentum and other organs were present but none were seen in the liver. Resection was not attempted and the patient died several months after surgery; no autopsy.

Three roentgenograms.

Roentgenographic Findings in an Early Case of Linitis Plastica. Franz J. Lust and Henry J. Heimlich. J.A.M.A. **173:** 139–142, May 14, 1960. (F. J. L., 18 E. 89th St., New York 28, N. Y.)

The authors report an early case of linitis plastica in a 44-year-old woman. For three years she had suffered from epigastric pains when hungry. X-ray examination revealed a hook-shaped stomach with an irregular area about 7 cm. in length on the greater curvature; this showed some pliability. Normal mucosal folds terminated abruptly at the site of the lesion. The mucosa in the region of the defect was irregular and had a cobblestone appearance. Spot compression films disclosed two shallow ulcerations.

An almost complete gastrectomy was performed. Examination of the excised segment of stomach showed thickening of as much as 13 mm., involving the greater curvature and the posterior and anterior walls, extending up to the lesser curvature. Two ulcerations were found on the greater curvature. Involvement extended grossly to within 4 cm. of the pyloric ring. Histologic sections showed diffuse neoplasm involving the gastric wall. Metastatic lymph nodes were not encountered. The diagnosis was linitis plastica.

Gastric syphilis, tuberculosis, and "innate fibrous tissue diathesis," as well as cancer, may lead to linitis plastica. The cancer responsible for linitis plastica is evidently of low virulence and slow growth, which allows the connective tissue proliferation to keep pace with the multiplication of the cancer cells. In benign lesions, a toxin may cause the fibroblastic proliferation. The term linitis plastica should be used to denote a particular histologic picture in which hypertrophy of muscular and connective tissue is seen. The cause of this condition is nearly always an infiltrating type of carcinoma, but it may be another type of tumor or, more rarely, an inflammatory process.

The roentgen signs are due to the infiltration in the gastric wall. Masses are rarely encountered. In most instances, the lesion commences at the pylorus and extends orally. The narrow rigid antrum and the normal corpus of the stomach produce the characteristic appearance which has been described as "leather-bottle" stomach. In the case reported here the antrum was not involved. The authors stress the importance of roentgen study of the gastric mucosa by a thin layer of contrast material. The changes are so minute that they can be seen only on a roentgenogram, not during fluoroscopy. The mucosal surface is irregular, without typical carcinomatous changes. There is a delineation between normal and abnormal, and the extent of the disease is demonstrated. In the early stages, linitis plastica roentgenologically shows some flexibility of the gastric wall and it is therefore distinguishable from other forms of carcinoma, in which constant rigidity of the stomach wall is observed.

Six roentgenograms. HAROLD A. SWANSON, M.D.
Calgary General Hospital, Calgary, Alta.

Retrograde Enterography. A New Method for the Roentgenologic Study of the Small Bowel. Edward A. Greenspon and Walter Lentino. Am. J. Roentgenol. **83:** 909–918, May 1960. (W. L., 60 Prospect Ave., Middletown, N. Y.)

The authors describe a new method for the roentgen study of the small bowel which they call "retrograde enterography." In this method the barium fills the bowel from below upward. The first step in the pro-

cedure is the passage of a modified 2-lumen Miller-Abbott tube, by which the small bowel is sealed off at a given point by a latex balloon. Following this, barium is introduced above the distended balloon and fills the bowel above it, each function being achieved through a separate lumen. A segment comprising about one-fourth of the small bowel, or less, may be examined fluoroscopically and roentgenographically. Filling of the bowel may be started or stopped at will; double-contrast or postevacuation roentgenograms can be made.

The intubation procedure is described in detail. When the tube is in place in the lower small bowel, the balloon is inflated with 50 to 60 c.c. of air. About 20 c.c. of the barium suspension is instilled through the large lumen of the tube and fluoroscopy or filming is carried out immediately. Additional barium suspension, in increments of about 200 c.c., is introduced until there is beginning overlapping of barium-filled coils of bowel, or until the patient becomes uncomfortable. About 600 c.c. of barium suspension can usually be tolerated if the barium is not cold and if it is instilled slowly.

The advantages of retrograde enterography are: (1) complete control of the filling procedure and (2) superior visualization of segments of small bowel. The method is not recommended for routine use but may be employed as an adjunct to ordinary barium studies for better evaluation of suspicious small-bowel lesions.

Sixteen cases have been examined by the retrograde technic. Five illustrative cases are reported.

Nine roentgenograms; 3 diagrams.

JOHN P. FOTOPOULOS, M.D.
Northwestern University Medical School

The Management of Acute Intestinal Obstruction. A Critical Review of 179 Personal Cases. Paul T. Savage. Brit. J. Surg. **47:** 643–654, May 1960. (Whittington Hospital, London, N. 19, England)

This paper is primarily a surgical and statistical review of 179 cases of acute intestinal obstruction, personally treated by the author. In 122 cases the obstruction involved the small bowel and in 57 the large bowel. Forty-three of the large-bowel obstructions were due to carcinoma. Well over a third of the patients were over seventy years of age. The overall mortality for the 179 cases was 15 per cent; for those under seventy it was 6.5 per cent.

The author stresses the value of supine and erect views of the abdomen, not only in the diagnosis of the presence or absence of obstruction but also in localizing its site. It is emphasized that even in acute intestinal obstruction, the roentgenograms may occasionally appear normal or nearly normal. Particularly in strangulating obstruction, the roentgen signs may be minimal compared to the findings at operation. In some instances faint evidence of a fluid level may be the only demonstrable abnormality. Actually, the author estimates, "false negative" roentgenograms of the abdomen are obtained in not more than 5 per cent of all cases of acute intestinal obstruction.

The disadvantages of preoperative Miller-Abbott decompression of the distended small bowel are discussed. An alternative method of small-bowel decompression by means of a special trocar designed by the author is advocated. The place of immediate resection and end-to-end anastomosis in large-bowel obstruction is also discussed.

Twenty-five figures, including 15 roentgenograms; 8 tables.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Entrance of Barium into Intestinal Glands During Barium Enema. Leon Sasson. J.A.M.A. **173:** 343–345, May 28, 1960. (1475 Grand Concourse, Bronx 52, N. Y.)

The author reports a case in which the intestinal glands were visualized roentgenographically after a barium-enema study. Fine spiculations of barium, uniform in appearance and 0.5–0.8 mm. long, were seen projecting at right angles from the margins of the transverse and descending colon on a postevacuation film. Because of the appearance of the spicules and the absence of other changes in the colon, prediverticula, ulcerative colitis, mucus, fecal residue, and other possible causes of contour irregularity were considered and discarded. It was thought that the spicules represented barium which had entered the lumens of some of the intestinal glands, rendering them radiopaque. Three weeks later a rectal biopsy disclosed no abnormalities.

Barium-enema examinations were then conducted on 5 unselected patients. After postevacuation films were obtained, sigmoidoscopy was performed, the residual barium was washed away, and a biopsy specimen was taken from the edge of the second or third rectal valve. In every case barium crystals were identified within the intestinal glands. In 1 patient the crystals had entered the lumen and had been deposited near the neck of the gland; in this area the cell membranes had ruptured, with obliteration of the intercellular boundaries.

The author concludes that barium enters the intestinal glands during barium-enema examination and that these glands are occasionally visible in a roentgenogram. Furthermore, these barium deposits may injure the cells of the glands. This may be the mechanism of formation of barium granulomas of the rectum after barium-enema studies.

Two roentgenograms; 4 photomicrographs.

HAROLD A. SWANSON, M.D.
Calgary General Hospital, Calgary, Alta.

Duodenocolic Apposition. M. H. Poppel. Am. J. Roentgenol. **83:** 851–856, May 1960. (550 First Ave., New York 16, N. Y.)

After describing briefly the anatomic proximity of the transverse colon and descending duodenum, the author discusses duodenocolic apposition, by which is meant a closer than normal relationship between these structures.

Normally, in the course of development, that portion of the anterior mesogastrium which extends from the duodenum to the liver becomes the hepatoduodenal ligament, while the caudal edge of the anterior mesogastrium at its junction with the duodenum fades out and becomes imperceptibly lost in the epithelium covering this portion of the bowel. Occasionally, the transverse colon, as it crosses the duodenum in its evolution, becomes attached to the caudal edge of the mesocolon and draws it out in a fold, more or less distinct, which persists and forms what is called the hepatocolic ligament. This consists of a peritoneal fold and extends usually from the gallbladder or the cystic duct across to the transverse colon or the transverse mesocolon, but does not affect the duodenum.

More rarely, we find the ventral layer of the caudal

edge of the anterior mesogastrium persisting or existing as a distinct fold and extending from the liver or gallbladder across the ventral surface of the duodenum and becoming lost in the peritoneum over the pancreas or in the ventral layer of the transverse mesocolon. It is the presence of such an abnormal fold of the ventral layer of the caudal edge of the anterior mesogastrium that causes a constriction of the duodenum which in its mildest form is represented by duodenocolic apposition.

There is a great variability in the degree of obstructive force exerted by this band or ligament on the duodenum with a consequent wide range in the intensity and nature of the symptoms produced.

In about 3 per cent of 500 patients with duodenal ulcer, roentgen examination showed a rather constant, closer than normal, apposition of the transverse colon to the descending duodenum sufficient to produce some degree of mutual indentation. This could be easily appreciated when both organs were simultaneously opacified. It implied some degree of duodenal stasis, playing a role in the physiopathology of the duodenal bulb. There was also some stasis in the transverse colon, as shown by the partially widened bowel containing an unusual amount of gas and feces.

Twenty-eight roentgenograms; 1 drawing.

DELANO Z. ARVIN, M.D.
Indiana University Medical Center

Diagnostic Value of Radiography in Volvulus of the Colon. Enrique Schwarz. Illinois M. J. **117**: 322–323, May 1960. (College of Medicine, University of Illinois, Chicago, Ill.)

Radiographic examination of the abdomen is of vital importance in the preoperative diagnosis of volvulus of the colon. This condition is more common at the sigmoid level than at the cecum or at the junction with the small bowel. The roentgen survey shows a hugely dilated loop of bowel with loss of the normal markings. Fluid levels can be seen on the upright films, in varying patterns depending upon the location of the volvulus. When torsion is at the level of the sigmoid, a double loop can be observed, occupying the entire abdomen, oriented toward the pelvis, and displacing the stomach, diaphragm, and other nondistended portions of the colon. In the roentgenogram obtained with the patient upright, several fluid levels can be seen. Barium-enema films sometimes show the site of torsion as a spiral or a bird's beak pattern, proximal to the dilated rectum. In cecal volvulus the cecum leaves the right lower quadrant of the abdomen and appears as a single, oval, distended segment of bowel, lacking haustrations, and showing fluid levels on the upright radiograph. The barium-enema examination may show the site of the torsion.

Volvulus of the transverse colon is rare. Only 4 cases are said to have been reported at the splenic flexure.

Six roentgenograms.

Frequency of Polyps of the Colon in Ulcerative Colitis. L. Andrén and S. Welin. Fortschr. a. d. Geb. d. Röntgenstrahlen **92**: 567–568, May 1960. (In German) (Malmö Allmänna Sjukhus, Malmö, Sweden)

Since 1953 the authors have been carrying out double-contrast x-ray examinations of the colon as a routine procedure. Among over 10,000 patients they have found ulcerative colitis in 61. In 25 of the 61 cases, polypoid tumors were found. The incidence of these tumors was four times as high in this group as would be expected in the usual series of patients seen because of suspected disease of the colon. The coexistence of the two diseases might be explained by the assumption that the colitis stimulates the growth of the tumors, or perhaps that the tumors produce the colitis by some kind of auto-immunization.

It is assumed that most carcinomas of the colon develop on the basis of a pre-existing polyp. Inasmuch as carcinoma of the colon is very frequent in ulcerative colitis, it seems reasonable to assume that this is due to the high incidence of polyps in that condition. Routine double-contrast x-ray examination is therefore recommended to assure an early diagnosis and to facilitate early surgical removal.

One roentgenogram; 1 table.

WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

The Value of Routine Lateral Rectal Projection in Barium Enema Study. Henry C. Forrester and A. Bradley Soule. Acta radiol. **53**: 113–119, February 1960. (University of Vermont College of Medicine, Burlington, Vt.)

It has been stated that the routine barium-enema study can no longer be considered adequate for examination of the colon in view of the excellent demonstration of lesions which may be obtained by the air-contrast technic, following adequate preparation of the patient. This statement probably does not apply as strictly to intraluminal defects, as produced by malignant neoplasms, as it does to the detection of polyps. While the air-contrast examination is undoubtedly superior, sufficient time, technical help, and equipment are not always available to make the procedure practical. Because the routine barium-enema study will continue to be the busy radiologist's mainstay for some time to come, the authors attempted to determine experimentally what technical factors should be employed and what barium-water suspension provides the best visualization of a rectal polyp in the lateral view.

A simulated polyp, consisting of a 1.5 cm. paraffin sphere, was suspended in an 8-cm. column of barium within an infinite Presdwood phantom. A roentgenogram of the "polyp" obtained under these conditions would correspond to a routine lateral projection with the bowel filled with barium. Barium-water mixtures ranging from 1:4 to 1:10 were used and applied against kilovoltage settings from 75 to 130, with appropriate changes in the milliamperage. It was found that a mixture consisting of one part of barium to six parts of water and a potential above 100 kv provided the best differential contrast and demonstration of the filling defect. Thicker mixtures, especially with lower kv values, tended to obscure the simulated polyp, while thinner mixtures at higher kv resulted in a loss of contrast.

These studies were applied to patients by insertion of the paraffin ball into the upper rectum and use of high kv, low mas, and 1:6 and 1:8 barium-water mixtures. With 130 kv, 50 mas, and a 1:8 suspension, the "polyp" was faintly seen; at other values, it was completely invisible. It is accordingly concluded that, while the routine use of the lateral projection in the barium-enema examination has definite merit in detecting *en face* filling defects in the rectum and rectosigmoid, the physical conditions inherent in the profile view of the barium-filled rectum make this procedure "unsatisfactory and

unreliable" for demonstration of a free-floating rectal polyp. This pertains even when high-kilovoltage technics and thin barium mixtures are employed. For discovery of such lesions an air-contrast examination is essential.

Two roentgenograms; 1 photograph; 1 table.

RALPH SCHLAEGER, M.D.
New York, N. Y.

Accuracy of Routine Gallbladder and Bile-Duct Studies. Ward Shaver. Minnesota Med. **43**: 321–324, May 1960. (715 S. Mill St., Fergus Falls, Minn.)

The results of 200 routine oral cholecystographic studies in 200 consecutive patients, beginning in January 1954, were reviewed and correlated with the subsequent hospital records of the same patients up to the spring of 1959. There was thus a time interval of from four to five years between the roentgen examination and the follow-up study.

Roentgen abnormalities had been reported in 79 cases (39 per cent). The gallbladder was visualized with calculi in 36 patients; 24 of these were operated on and in all 24, cholecystitis and cholelithiasis were demonstrated surgically. In 12 cases there was nonvisualization with calculi; 10 of this group were confirmed surgically. Nonvisualization without opaque calculi was demonstrated in 31 patients; 21 of these were operated on and showed disease: there was 1 case of carcinoma of the gallbladder with stones, 1 of carcinoma of the common duct, 16 of calculi and cholecystitis, 3 of cholecystitis alone. Function was thought to be normal on roentgen examination in 121 cases, *i.e.*, there was some concentration of medium, no calculi or polypi were seen within the gallbladder, and there were no Rokitansky-Aschoff sinuses or calcification in the gallbladder wall. Four of this group of 121 patients were operated on, however, with a preoperative clinical diagnosis of cholecystitis. In 2 the findings were normal but 1 had subsequent admissions for abdominal complaints. The third patient received a pathological report of "mild cholecystitis, no calculi" but entered the hospital on three subsequent occasions with varying diagnoses such as functional dyspepsia and gastritis. In the fourth patient the irregular and unusual shape of the gallbladder raises the suspicion of surrounding adhesions. The surgeon reported several adhesions and a small stone in the cystic duct.

Less satisfactory results were obtained in a series of 52 patients examined by intravenous cholangiography in 1957 and 1958. Approximately 36 per cent of the cholangiograms showed such faint concentration of medium as to yield little if any information of value. In about 19 per cent of the cases the concentration was good enough to evaluate the size of the common duct and persistence of opacification, two of the criteria for diagnosis, but it was impossible to exclude the possibility of filling defects or a cystic duct remnant. In the remaining 34 per cent, a definite diagnosis could be made. It is thought that laminagraphy may improve the results.

One table.

The Reliability of Telepaque Cholecystography. D. A. Alderson. Brit. J. Surg. **47**: 655–658, May 1960. (King's College Hospital, London, S. E. 5, England)

Cholecystography was performed in 315 patients, with Telepaque as the contrast medium. The procedure for the examination was that in general use, including an oral dose of 3 gm. of Telepaque and the usual scout films, *i.e.*, prone oblique and upright views. In all instances the radiologic report was correlated with the surgical and pathological findings.

In the author's series there were only 3 errors of diagnosis among the 315 cases, an accuracy of 99 per cent. (1) Two stones were overlooked in a normally concentrating gallbladder. (2) Concentration of the medium was considered less than normal in a gallbladder found at surgery to be normal. (3) A normally concentrating gallbladder showed cholesterosis at operation. Only 2 gallbladders reported as normal were found at operation to be diseased.

The results in this series in which Telepaque was employed compare favorably with those in other series using earlier media. The author agrees with Mauthe (Wisconsin M. J. **53**: 473, 1954. Abst. in Radiology **65**: 134, 1955) that "the method practically never fails to reveal pathology when this is present and that to proceed to cholecystectomy in the face of a normal cholecystogram is difficult to justify." He is of the opinion that oral cholecystography should be performed first in almost all cases, and that, as a rule, use of an intravenous medium should be reserved for the patient whose gallbladder has been removed and for those in whom oral cholecystography has been unsuccessful.

Three tables.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

A Comparative Clinical Evaluation of a New Oral Cholecystographic Medium, Orabilex, with Telepaque. J. P. O'Laco and William A. Wilcox. Wisconsin M. J. **59**: 249–251, April 1960. (W. A. W., Milwaukee County Hospital, Wauwatosa, Wisc.)

Two cholecystographic studies were made in each of 103 patients, one with Telepaque (iopanoic acid) and one with Orabilex (bunamiodyl). The dosages were held constant throughout the series: 6 tablets of Telepaque equal to 3 gm. and 6 capsules of Orabilex equal to 4.5 gm. The interval between examinations ranged from three to six days in 80 per cent of the patients and varied from two to one hundred and twenty days in the remainder. In 47 patients Orabilex was given in the initial study and in 56 Telepaque was used first. The studies were made to compare the gallbladder opacification, bowel residual, and side-effects of the two media, and to evaluate the significance of nonopacification with Orabilex against the more familiar Telepaque.

In 21 patients the gallbladder was not visualized with either Orabilex or Telepaque. In 6 cases there was no opacification with one medium and some with the other. It is thought possible that in these cases the first study augmented the second. In 76 patients there was satisfactory opacification with both substances. The examinations were judged equally satisfactory in 66 patients (64 per cent); Orabilex was thought better in 30 (29 per cent); Telepaque was considered superior in 7 (7 per cent). With Orabilex fewer side-effects appeared and bowel residual was less apt to interfere with gallbladder evaluation.

Two roentgenograms; 3 tables.

The Distended Gallbladder: The Value of a Fat Meal in Cholecystography. Maurice D. Sachs and Philip F. Partington. Am. J. Roentgenol. **83**: 835–842, May 1960. (VA Hospital, Cleveland, Ohio)

The practice of omitting a fat meal during oral

cholecystography is an unwarranted sacrifice of potentially valuable information, particularly concerning the common bile duct. Normally, the gallbladder contracts 25 to 50 per cent of its original volume during the first forty-five minutes after a fat meal. Demonstration of the common duct is increased by the subcutaneous injection of 1 c.c. 1:4,000 Prostigmine before this meal.

The visualization of a well filled or distended gallbladder that fails to empty in response to a repeat fat meal should alert the radiologist to the possibility of urgent and often serious disease involving the bile ducts. If a repeat fat meal fails to make the gallbladder contract, and to show the common duct, intravenous Cholografin is employed. The common bile duct is best seen at about thirty minutes after injection, since the density of the shadow will have decreased at forty-five minutes. The repeat fat meal or intravenous Cholografin studies supplemented with laminagraphy will usually reveal the location of the lesion.

Lesions which prevent the gallbladder from emptying are limited to inflammatory and neoplastic conditions involving the common duct, sphincter of Oddi, and duodenum in the region of the sphincter of Oddi. These include cancer of the common duct or head of the pancreas, chronic pancreatitis of the head of the pancreas, prolonged spasm or fibrotic stenosis of the sphincter of Oddi, and carcinoma of the duodenum in the vicinity of the sphincter of Oddi.

Delay in establishing the nature of the lesion involving the bile ducts until the occurrence of clinical jaundice renders preoperative roentgen diagnosis virtually impossible, and may rule out the possibility of curative surgery.

Fourteen roentgenograms.

ROSCOE E. MILLER, M.D.
Indiana University Medical Center

Recent Experiences with Spontaneously Disappearing Gallstones. Harvey J. Dworken. Gastroenterology **38:** 76–86, January 1960. (2460 Fairmount Blvd., Cleveland 6, Ohio)

The migration of gallstones from the gallbladder is facilitated most often by a fistulous communication between the gallbladder or bile ducts and the intestinal tract. On the other hand, calculi may vanish by dissolution in the gallbladder or by passage through the normal ductal pathways.

Five cases are reported in which gallbladder calculi documented roentgenographically on one occasion during the patient's illness had disappeared by the time of surgery. In 4 of the 5 patients interval cholecystograms had foretold this disappearance. In the fifth case, multiple radiolucent calculi were demonstrated in a functioning gallbladder one month preceding surgery, and confirmation of their presence by repeat cholecystography was not attempted. In none of these cases was an open fistula found between the gallbladder and intestine.

The author reviews the various possibilities to explain the disappearance of the gallstones in this group of patients. These include a consideration of the validity of the initial diagnosis, dissolution of the stones in the gallbladder, transit through a fistula which subsequently closed, and passage of the stones into the intestine *via* the duct system prior to or at the time of surgery.

It is recommended that cholecystography be repeated prior to operation in patients with previously demonstrated gallstones, particularly if the stones are small or are associated with a recent pregnancy or relapsing pancreatitis.

Nine roentgenograms.

RALPH SCHLAEGER, M.D.
New York, N. Y.

Benign Neoplasms of the Gallbladder: Diagnosis and Surgical Implications. Seymour Fiske Ochsner and Alton Ochsner. Ann. Surg. **151:** 630–637, May 1960. (Ochsner Clinic, New Orleans, La.)

During the fifteen-year period ending in 1959, 1,523 gallbladders were removed at surgery at the Ochsner Clinic (New Orleans, La.); in 45 of these there were benign mucosal tumors. Cholesterol and inflammatory polyps are not considered true tumors and are not included in the number. The tumors were of five types: adenoma (18 cases); papillary adenoma (15 cases); adenomyoma (9 cases); noninvasive carcinoma (2 cases); fibroadenoma (1 case). Fourteen patients had multiple lesions, 21 had associated gallstones, and 34 had associated cholecystitis.

Benign neoplasms of the gallbladder produce no specific symptoms; occasionally a pedunculated growth becomes detached and causes pain in passing through the ducts. The essential radiographic finding is a fixed radiolucent defect in the opacified gallbladder. Usually the shadow is small, from 2 to 10 mm. in diameter. It may mimic a radiolucent gallstone, but its constant position should alert one to the correct diagnosis. The presence of associated gallstones may prevent the specific diagnosis of tumor, either by casting other movable radiolucent shadows or by producing (with cholecystitis) nonvisualization of the gallbladder.

The authors are of the opinion that the demonstration of fixed radiolucent shadows on the cholecystogram is an indication for surgical removal of the gallbladder. The mucosal tumors are probably precancerous and, if a stone or polyp is found at surgery, the patient still has been properly treated.

Three roentgenograms; 1 photograph; 2 photomicrographs; 5 tables.

MAJOR MARTIN A. THOMAS, M.C.
Lackland AFB, Texas

Pseudoconcretions in Precipitate of Contrast Medium in the Gallbladder. Georg Theander. Am. J. Roentgenol. **83:** 828–830, May 1960. (Malmö Allmänna Sjukhus, Malmö, Sweden)

The author has previously described the roentgenographic appearance of contrast medium precipitate in the gallbladder on the basis of observations in 9 cases (Acta radiol. **52:** 297, 1959. Abst. in Radiology **75:** 323, 1960). Stone-like, radiolucent formations may occur within such a precipitate despite the definite absence of gallstones, as proved by normal cholecystograms after disappearance of the precipitate. These "pseudoconcretions" can usually be identified by their change in shape and subsequent disappearance, as the precipitate disappears, in contrast to the persistence of true stones.

A case is reported which illustrates the close resemblance between pseudoconcretions and true stones in a precipitate. In this case, cholecystography with the sodium salt of iopanoic acid (Bilijodon-natrium) on five or six occasions showed a radiopaque mass and several minute, stone-like, radiolucent formations. At one examination, neither the mass nor the gall-

bladder was visualized. Despite the fact that cholecystectomy was performed less than three hours after the last examination showing the precipitate and radiolucent formations, and the cystic duct was ligated as soon as possible to prevent escape of the gallbladder contents, no precipitate or stone-like formations could be found within the excised gallbladder.

Contrast medium precipitate has not previously been observed to disappear definitively as long as the gallbladder contained sufficient contrast material to demonstrate the organ roentgenographically. The radiolucent formations within the precipitate in the present case were proved to be pseudoconcretions only by their disappearance concurrently with the precipitate. Roentgenographically, they had not been observed to change shape or size, nor had they disappeared before operation as long as the gallbladder was visualized. Re-examination with some contrast agent not known to produce precipitation might aid in the differentiation from true stones.

Four roentgenograms.

JOHN P. FOTOPOULOS, M.D.
Northwestern University Medical School

Percutaneous Transhepatic Cholangiography. Allan A. Kaplan, Leonard Brodsky, and John M. Rumball. Am. J. Digest. Dis. **5:** 450–457, May 1960. (VA Hospital, Coral Gables, Fla.)

The authors believe that percutaneous transhepatic cholangiography (see also Nurick, *et al.* Brit. J. Surg. **41:** 27, 1953. Abst. in Radiology **62:** 780, 1954; Kidd. Arch. Surg. **72:** 262, 1956. Abst. in Radiology **67:** 907, 1956) should take its proper place in the armamentarium of biliary diagnostic procedures. They have carried it out in 8 patients. In 6, successful studies demonstrated the sites of obstruction; in 2 a biliary radicle could not be found and at subsequent surgery the jaundice proved to be nonobstructive. Its use is illustrated by a case report of a 53-year-old white male in whom the procedure indicated a block at the ampulla of Vater. This was confirmed at surgery when a carcinoma was found at that site.

The major hazard is bile leakage and chemical peritonitis. These should be obviated by proper technic.

The procedure is indicated only when the diagnosis remains in doubt after every means short of exploratory surgery has been tried. In the absence of an easily palpable liver and jaundice, other measures of visualizing the biliary tree should give adequate information. Transhepatic cholangiography may be attempted after the abdomen is opened in selected instances in which adequate exploration of the extrahepatic ducts does not satisfactorily explain the cause of obstruction and intrahepatic biliary duct block is suspected. It is suggested that the procedure at the operating table may be less hazardous than retrograde cholangiography and may afford more information.

Three roentgenograms; 1 photomicrograph; 1 table.

Intravenous Cholangiography with Sodium Iodipamide: The Problem of Nonvisualization. Martin H. Floch and Abraham Geffen. Am. J. Digest. Dis. **5:** 440–449, May 1960. (A. G., Beth Israel Hospital, New York, N. Y.)

It is the purpose of this paper to evaluate the reasons for nonvisualization of the biliary tract by a correlation of laboratory and surgical findings. A definite relation between hyperbilirubinemia and nonvisualization was found. Concentration of the medium is usually poor in the presence of hyperbilirubinemia and the incidence of nonvisualization is highest among patients with elevated bilirubin levels although visualization occasionally occurs in this group.

Sodium iodipamide, 40 ml. of a 20 per cent solution, was used for the examinations. Laminagrams were obtained in every instance in an attempt to demonstrate the biliary tract and there was a follow-up of at least two hours before the diagnosis of nonvisualization was established.

No visualization was obtained in 37 (16.5 per cent) of 223 intravenous cholangiographic studies. Of these 37 patients 35 had clinically or surgically proved liver and/or biliary tract disease (12, common duct calculi; 10, nonmalignant liver disease; 7, carcinoma; 5, cholelithiasis; 1, pancreatitis); in 2 cases there was incomplete evaluation.

Twelve of 36 patients with nonvisualization had normal bilirubin levels at the time of examination; 24 (67 per cent) had hyperbilirubinemia. Only 16 (44 per cent) had a level greater than 3 mg. per cent. The last 16 included 7 cases of common duct calculi; 5 of nonmalignant liver disease; 2 of carcinoma; 1 of cholelithiasis; and 1 of pancreatitis.

Nonvisualization was no more frequent in patients who had had biliary tract surgery than in those who had not.

Serum bilirubin determinations were obtained in 161 of the 186 patients with adequate biliary tract visualization. In 150 of these (93 per cent) the levels were below 3 mg. per cent and in 11 they were greater than 3 mg. per cent (over 4 mg. in 3). There was excellent visualization in several patients with markedly abnormal liver function; in 16 of these with bilirubin levels below 3 mg. per cent there was significant Bromsulphalein retention.

It is postulated that the mechanism of sodium iodipamide excretion depends on a specific liver cellular function. Its exact relation to liver and biliary physiology remains to be elucidated.

Two graphs; 1 table.

Effect of Secergan on the Duodenum and Common Bile Duct. Paul Edholm. Acta radiol. **53:** 125–128, February 1960. (Karolinska Sjukhuset, Stockholm, Sweden)

The effect on the duodenum and common bile duct of Secergan (a quaternary phenothiazine compound with anticholinergic and ganglion-blocking action) was investigated roentgenologically, with particular attention to the inhibition of peristalsis and spasm. These studies were predicated on previous experiments which established that high concentrations of the drug could be found in the liver, gallbladder, bile ducts, and the small intestine near the ampulla of Vater up to one hour after parenteral administration.

In man, 20 mg. of Secergan injected intramuscularly during upper gastrointestinal examination resulted in cessation of all duodenal peristalsis and a widening of the caliber of the lumen. Accordingly, the drug may be of value when spasm prevents satisfactory filling of the duodenum.

Cineradiography, during operative and postoperative cholangiography, was performed with 30 per cent Urografin prior to and after the administration of Secergran. A few minutes following the intramuscular injection of the compound, the normal synchronous

contraction of the sphincter of Oddi with the adjacent duodenum ceased, and the sphincter remained open. It was found that the drug relaxed the spasm of the duodenum and the sphincter of the common bile duct induced by morphine or by the mechanical trauma of duct exploration.

In 144 patients subjected to preoperative cholegraphy, Secergan uniformly produced cessation of contractions in the duodenum and the sphincter, with a resultant increase in width of the common duct. The inhibition of sphincteric activity produced improved filling of the distal portion of the duct, as well as delineation of the entire extrahepatic biliary tree.

Six roentgenograms. RALPH SCHLAEGER, M.D.
New York, N. Y.

THE MUSCULOSKELETAL SYSTEM

Albers-Schönberg's Disease. A Changing Concept. R. D. Montgomery and K. L. Standard. J. Bone & Joint Surg. **42-B:** 303–312, May 1960. (R. D. M., University College of the West Indies, Mona, St. Andrew, Jamaica)

In 1904, Albers-Schönberg first described the radiological appearance of marble bones; his patient was a healthy twenty-six-year-old man who had sustained fractures since childhood. In the ensuing years Albers-Schönberg's disease (osteopetrosis) came to be regarded principally as a grave and progressive disorder of infancy. In the fulminating form, manifest from birth, fractures and deformity, hydrocephalus, and cranial nerve palsies lead to early death from intractable anemia and intercurrent infection. In other cases the stigmata are delayed until later childhood, when retardation of growth and of mental and sexual development occurs, not infrequently accompanied by rickets, dental caries, and osteomyelitis.

With the expansion of radiological exploration, a number of cases have been found in adults, and it is now possible to define a common pattern. The clinical findings of 20 writers, including Albers-Schönberg, were summarized by Hinkel and Beiler in 1955 (Am. J. Roentgenol. **74:** 46, 1955. Abst. in Radiology **66:** 792, 1956). Their picture is that of a benign osteosclerotic disorder encountered at all ages and in all races, which may remain symptomless or may reveal itself by abnormal fractures. Anemia is found in less than half of the cases and hepatosplenomegaly is rare. Radiologically, the bones of the pelvis are always affected, the long bones nearly always, and the bones of the extremities, the skull base, and vertebrae commonly. The blood chemistry is normal. The condition is strongly familial in one generation, and at least a quarter of the parents are consanguineous.

The authors describe a type of bony sclerosis which they discovered in 9 members of a Jamaican family and which resembles the more benign form of Albers-Schönberg's disease. The parents were second cousins. Facial palsy developed in 3 of the patients at the same age (six years); 2 of these exhibited no other clinical abnormality, while the third had bilateral optic atrophy and proptosis. All members of the family were investigated. The radiological changes in this family showed a predilection both for the base of the skull, which was intensely involved, and for the calvarium. Changes in the pelvis occurred in all cases with skull involvement; the distribution in other bones was typical, but certain features often observed in this condition were lacking. In all the less severely affected bones there was a uniform increase in density with little loss of trabecular pattern and with thickening of the cortex at the expense of the medulla. Even in the mildest cases the transverse diaphysial band, sclerotic nidus, and "sandwich" vertebrae were absent. Serum studies disclosed increased alkaline phosphatase activity. These features are discussed in the light of present-day knowledge and theory of the pathology of Albers-Schönberg's disease.

Nine roentgenograms; 3 photographs; 1 table; 1 genealogical chart.

Osseous Localizations of Eosinophilic Granuloma. Louis Jeanmart-Michez. J. belge de radiol. **43:** 135–176, 1960. (In French) (Hôpital Saint-Pierre, Brussels, Belgium)

This is an extensive review of the etiology, pathogenesis, clinical, pathological, and radiological findings in eosinophilic granuloma, particularly as it involves the bones. Relationship with Hand-Schüller-Christian and Letterer-Siwe disease is discussed. Agreement is expressed with many other investigators that these three diseases are expressions of the same fundamental process.

Three cases of eosinophilic granuloma in various skeletal locations are reported, in all of which roentgen therapy alone or combined with surgery led to complete recovery. Two cases of Letterer-Siwe disease are also presented, with fatal evolution.

Nineteen roentgenograms.

CHARLES M. NICE, JR., M.D., PH.D.
Tulane University

Tuberous Sclerosis Complex. Unusual Case of Adenoma Sebaceum, Tuberous Sclerosis, and Extensive Bone Lesions. Junji Hasegawa and Royal E. Ihrke. J.A.M.A. **173:** 150–153, May 14, 1960. (303 E. Chicago Ave., Chicago 11, Ill.)

The case is reported of a 27-year-old woman who requested treatment of a "birthmark" in the right infraorbital area. She gave evidence of mental deficiency and a history of epilepsy. The cutaneous lesion proved to be adenoma sebaceum. Roentgen examination revealed widespread osseous aberrations, involving the spine, pelvis, and calvarium. The frequency of bone changes in the tuberous sclerosis complex warrants a complete skeletal survey in patients with adenoma sebaceum.

Three roentgenograms; 2 photographs.

WILLIAM MARTEL, M.D.
University of Michigan

Simultaneous Occurrence of Osteitis Deformans and Hodgkin's Disease. Arthur E. Davis, Jr. J.A.M.A. **173:** 153–157, May 14, 1960. (404 Third Ave., S., St. Cloud, Minn.)

The simultaneous occurrence of osteitis deformans (Paget's disease) and Hodgkin's disease in the tibia of a 62-year-old man is reported. Roentgen examination revealed a mottled sclerotic process involving the upper third of the tibia, with possible malignant changes. Lymphoma of the bone can produce a mosaic pattern similar to that found in osteitis deformans, but in the author's patient both diseases coexisted, probably fortuitously. The concurrence of Paget's disease with other pathological entities has been recorded, but this is

believed to be the first time that Paget's disease and Hodgkin's disease have been observed in the same bone.

Two roentgenograms; 5 photomicrographs.

WILLIAM MARTEL, M.D.
University of Michigan

Scoliosis: Diagnosis and Natural History. W. T. Mustard. Canad. M.A.J. **82**: 815–821, April 16, 1960. (Hospital for Sick Children, Toronto, Ont., Canada)

On the basis of fifteen years experience with scoliosis at the Hospital for Sick Children, Toronto, including 160 spine fusions, the author makes several specific recommendations. The diagnosis of curvature from any cause should be made early. Slight curves in the young child should not be treated with complacency. In any child with scoliosis, a standing roentgenogram should be obtained and if the patient is under ten years of age he should be followed clinically each year. Any increase in curvature demands further roentgen study. After the age of ten the deformity may increase rapidly and the child should be seen every three months. A curvature of 25 to 30° in the age group of ten to thirteen years, where the iliac apophyses have not appeared, will increase with growth. Correction and spinal fusion will arrest growth and the curve will not increase.

Twelve roentgenograms; 1 photograph; 2 diagrams; 1 graph.

Intervertebral Disk Protrusions in Childhood and Adolescence. John E. A. O'Connell. Brit. J. Surg. **47**: 611-616, May 1960. (St. Bartholomew's Hospital, London, E. C. 1, England)

Of 1,200 patients with surgically proved lumbar disk protrusions seen at St. Bartholomew's Hospital (London), 38 (3.2 per cent) were under eighteen years of age. The findings in these 38 patients are reviewed and contrasted with those in a series of 500 patients unselected as regards age, from whom lumbar disk protrusions were excised (O'Connell, J. Bone & Joint Surg. **33-B**: 8, 1951. Abst. in Radiology **58**: 150, 1952). Sixteen of the 38 patients were females and 22 males; in the other series the incidence of disk protrusion was higher in males. In a few of the patients, symptoms began before the age of twelve.

The outstanding symptom of lumbar disk protrusion in children, as in older patients, is pain. Symptoms arising in childhood and adolescence may persist for long periods before diagnosis is made and treatment instituted. In four-fifths of the present series the pain involved the low back and posterior crural areas together, while in the remainder it was confined to the lower limb. In 61 per cent of the group the crural pain was left-sided. This left-sided preponderance was also noted in the earlier series. The protrusion occurred at the last joint in 50 per cent of the patients and at the next to the last joint in 45 per cent. In 2 patients protrusions at both levels were present.

The degree of reduction of spinal flexion and the frequency of occurrence of lumbar kyphosis were considerably greater in the young patients than in the cases previously reviewed. In the young patients, also, the reduction in straight leg raising was in general very much more marked than in the older ones. Neurologic signs, however, were absent more often than in the older patients.

Definite radiological changes indicating the presence of a disk protrusion, narrowing of an intervertebral space with or without lipping of the adjacent vertebral margins, were seen in only one-fifth of the patients, with doubtful changes in a further one-third of the group. In almost half of the patients there was no evidence of disk protrusion on the plain film. Eleven patients had congenital anomalies of the spine. Myelography, performed in 10 patients, definitely showed disk protrusion in 6; findings were doubtful in the other 4.

A clinical picture similar to that of a lumbar disk protrusion may be produced (1) by other lesions within the lower portion of the spinal canal, *e.g.*, neoplasm or meningocele, or (2) by lesions of the spinal column, particularly spondylolisthesis and ankylosing spondylitis.

The etiology of disk protrusions in childhood and adolescence is discussed. It is suggested that stresses occasioned by the period of rapid growth may be a factor of some importance. Trauma in one form or another was thought to have been significant in 25 of the 38 cases (66 per cent).

The findings at operation did not differ from those in older patients, except that the disk tissue excised frequently appeared to contain more fluid; the average weight of the tissue removed was greater than in the adult series. Three of the 38 patients have been lost to follow-up; 91 per cent of the remainder considered themselves either cured or greatly improved by the surgical treatment.

One graph; 15 tables.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Early Diagnosis of Congenital Dysplasia and Congenital Dislocation of the Hip. Value of the Abduction Test. Lloyd E. Harris, Paul R. Lipscomb, and John R. Hodgson. J.A.M.A. **173**: 229–233, May 21, 1960. (Mayo Clinic, Rochester, Minn.)

Hip abduction testing of 11,010 infants, as a screening procedure, disclosed 12 cases of congenital dysplasia of the hip with dislocation and 10 cases of probable dysplasia. All infants were examined on the first day of life, and again on the fifth day; 90 per cent had examinations at regular intervals for six years. The average age at diagnosis of dislocation in this series was four months, as compared to fourteen months prior to routine use of the test. A normal result with the abduction test at birth does not exclude the possibility that dysplasia or dislocation may become evident later, and the test should be part of the examination of all infants at monthly intervals through at least twelve months of age. Full 90° abduction is unusual after the neonatal period; during the second through the eighth or ninth month, abduction is frequently in the range of 60 to 70°. Abduction limited to 60° or less warrants roentgen examination. Abduction may also be limited because of other conditions, such as arthrogryposis multiplex, moderate to severe spasticity, and coxa plana.

The authors believe that the abduction test is a valuable simple screening procedure for the detection of congenital disease of the hip and that it is more sensitive than Ortolani's sign (jerk), unequal thigh creases, unequal gluteal creases, unequal length of the legs, external rotation of one leg, and a "clicking" sound on abduction of the hips. In the present series all children are now at least three and a half years of age, and in no infant whose progress has been followed has dislocation become evident after weight-bearing age.

The diagnosis of congenital dysplasia of the hip was

limited to those infants who showed roentgen evidence of luxation. A definite diagnosis is based on the demonstration of upward displacement of the upper end of the femur, an increased acetabular index, and poorly developed epiphysial nucleus; except in the newborn infant, an iliac stress line is often observed. Probable congenital dysplasia is diagnosed on the basis of a positive abduction test, an increased acetabular angle, and subsequently a delay in the appearance of ossification of the capital femoral epiphysis, with no displacement of the head of the femur.

Three roentgenograms; 2 drawings.

PHILIP M. JOHNSON, M.D.
Montclair, N. J.

Steroid Arthropathy of the Hip. D. R. Sweetnam, R. M. Mason, and R. O. Murray. Brit. M. J. **1**: 1392–1394, May 7, 1960. (The London Hospital, London, England)

Rapid destruction of the femoral head with consequent disorganization of the hip joint rarely, if ever, occurs in uncomplicated rheumatoid arthritis or osteoarthritis. Recently the authors had seen 4 patients, all treated with corticosteroids, in whom rapid destruction of the femoral head developed. The striking feature in each case was the relative freedom from pain in the presence of severe joint disintegration. These changes may result from either oral or intra-articular steroid therapy. The hip joint seems particularly prone to destruction, presumably because of the enormous force transmitted through it. Progressive deterioration may occur in an apparently normal hip joint during steroid therapy, but susceptibility may be increased by preexisting rheumatoid arthritis or osteoarthritis. In 3 of the author's patients the x-ray appearance of the hips was almost indistinguishable from that of typical Charcot joint. While the dose of steroids required to produce joint changes varies greatly, it does seem that when the steroids are given by mouth a relatively high dose is required over a prolonged period. In the author's fourth patient, who was being treated for pemphigus, roentgen examination showed only early destructive changes after oral steroid therapy in high dosage for three and a half years.

Careful observation of patients on long-term or high-dose steroid therapy is essential so that the early evidence of hip destruction may be detected and treatment adjusted accordingly.

Seven roentgenograms. HANS A. LINDT, M.D.
Cleveland Metropolitan General Hospital

Erosion of the Femoral Shaft Due to Patello-Femoral Osteoarthritis. Colin Alexander. Clin. Radiol. (J. Fac. Radiologists) **11**: 110–113, April 1960. (Public Hospital, Auckland, N. Z.)

The author has seen 8 patients with erosion of the anterior distal femoral shaft associated with severe patellofemoral osteoarthritis. In these cases, lateral views of the extended knee showed the patella to be abnormally close to the femur within the eroded area, suggesting that the erosion was caused by the chisel-like arthritic patella. Both knees were examined in 6 of the patients; in 3 the erosion was bilateral. All of the 14 knees which were radiographed revealed severe patellofemoral osteoarthritis characterized by gross cartilage loss and marginal lipping. This condition is usually due to chondromalacia patellae. In 10 of the 11 knees with shaft erosion, severe erosion of the anterior one-fourth of the lateral femoral condyle articular surface was also identifiable. Ten knees showed osteoarthritis of the main tibiofemoral joint, but in no case was it severe.

Since it was obvious that the erosion was caused by the close approximation of the arthritic patella to the femoral shaft when the knee was extended, roentgenograms were taken of 50 normal knees in extension. In these roentgenograms it was found that only the lower pole of the patella is in contact with the femur, resting on the upper end of the femoral articular surface. The axis of the patella was always either parallel with the shaft, or diverged from it. In the normal cases the patellofemoral distance ranged from 7 to 14 mm., with an average of 1 cm. In the 4 eroded knees with films in extension, this distance averaged 2 mm.

The normal patellofemoral gap is maintained by the articular cartilage on the patella and femur and the anatomical prominence of the femoral condyle. Loss of the entire cartilage would bring the patella approximately 5 mm. closer to the femur, but it would still in most instances be too far away to erode bone. The final factor permitting erosion is probably femoral articular condyle erosion (which was demonstrated in 10 of 11 knees).

The mean age of the 8 patients in the present series was sixty-nine years; 7 of the patients were women. The predominance of women with this condition is attributed to the fact that osteophytic reaction is more common in men. Formation of an osteophyte of the anterior femoral condyle keeps the patella at its normal distance, preventing erosion. The more atrophic response in women is less likely to afford this protection. The only significance of the erosion described is that it might mislead the radiologist into diagnosing tumor erosion, particularly if an effusion were present in the suprapatellar pouch.

Seven roentgenograms.

SAMUEL B. HAVESON, M.D.
Lynwood, Calif.

The Pathology of Slipped Upper Femoral Epiphysis. A New Concept. A. M. Rennie. J. Bone & Joint Surg. **42-B**: 273–279, May 1960. (Newton of Pitfodels, Cults, Aberdeen, Scotland)

The author calls attention to an observation that may be of importance in the diagnosis of slipped femoral epiphysis. He feels that it is too easily assumed that slipping is the first recognizable change in the position of the femoral head. In a study of lateral radiographs of slipped epiphyses, he has been impressed by the frequency with which the back of the femoral neck is materially shorter than the front. An index of this may be obtained by measuring "the angle of tilt." This is the posterior angle enclosed by a line passing through the apices of the anterior and posterior corners of the metaphysis, and one drawn at 90° to the rectilinear shadow cast by the lateral part of the front of the femoral neck. In 20 normal children, the angle of tilt was found to average 10°, while in 36 patients with slipped epiphysis, the average was 30.5°.

The author contends that the relatively greater length of the front of the femoral neck is due to primary failure of growth of the back of the femoral neck. The most likely cause for this failure of growth is compression of the back of the epiphyseal plate. Such compression could be applied acutely by forced lateral rotation in extension, but in the majority of cases it is believed that

a static compression force plays a part, especially in patients who are overweight. A primary abnormality of the cartilage of the epiphyseal plate renders it susceptible to the effects of compression. Because this abnormality is diffuse, deformities of a similar etiology have been found elsewhere, notably in the spine, in patients with slipped upper femoral epiphysis.

Twenty-five roentgenograms.

CAPT. HARRIS W. KNUDSON, M.C.
Lackland AFB, Texas

Familial Epiphysial Dysplasia of the Lower Limbs. H. Weinberg, M. Frankel, M. Makin, and E. Vas. J. Bone & Joint Surg. **42-B:** 313–332, May 1960. (H. W., Rothschild Hadassah University Hospital, Jerusalem, Israel)

A family has been seen by the authors in which the changes characteristic of dysplasia epiphysialis multiplex were confined to the lower limbs. The family comprised six generations and consisted of 114 members, 7 of whom could not be traced. Of the 107 persons, with whom this paper is concerned, 22 males and 23 females were affected, while 32 males and 30 females were unaffected. The severity of the disease was extremely variable.

The radiological findings were characteristic and diagnostic. No abnormality was seen in roentgenograms taken during the first months of life. The earliest significant deviation from normal was delay in the appearance of the ossific center of the femoral head. When this epiphysis first became demonstrable, between the ages of one and two years, it was seen to be poorly developed, irregular in shape and density, and mottled. When weight bearing began, the epiphysis became fragmented and the femoral head flattened. There was usually delay in the appearance of the trochanteric epiphyses, suggesting that the whole epiphysis at the proximal end of the femur was involved. Later, the femoral neck became plump and shortened. Even though the density of the epiphyses became normal, the femoral head remained deformed and flattened. The epiphyseal plates of the femoral head and of the trochanter were usually closed by the age of fourteen to fifteen years. The femoral head was often severely deformed, and the neck was shortened and broadened and showed pronounced varus deformity. The greater trochanter seemed overdeveloped. There was mushrooming of the head so that the proximal femur often appeared hatchet-shaped. Coxa magna deformity with secondary subluxation of the hip commonly occurred. Shallowness of the acetabulum was considered to be secondary to the deformity of the femoral head.

At the knee, both lower femoral and upper tibial epiphyses were affected. In some the condyles were altered in shape, and separate centers of ossification at the back of the femoral condyles were not uncommon. Genu valgum or genu varum was often present. The distal tibial epiphyses were frequently irregular in outline and deformed, and some obliquity of the ankle joint was common because the lower tibial epiphysis was much thicker medially than laterally. Several cases showed flattening and irregularity of the talus, with compression of its upper surface. In other cases sclerosis and deformity of the navicular bone were observed. The shafts of the long bones of the lower limbs, while not deformed or thickened, were shorter than normal.

Variations from Fairbank's description of dysplasia epiphysialis multiplex are discussed.

Long term follow-up studies are presented.

Sixty-one roentgenograms; 8 photographs; 1 genealological chart.

THE GENITOURINARY SYSTEM

Value of Tomography in the Urographic Study of Infants and Children. Cl. Béraud, P. Deffrenne, and R. Bressieux. J. de radiol. **41:** 230–235, May 1960. (In French) (Hôpital Debrousse, 35, Chemin Saint-Irénée, Lyon 5e, France)

Tomography is of great value in urography, especially in infants, in whom there are so many gaseous shadows overlying the renal regions. Tomography gives better visibility of the kidneys, indicating the number of calyces, and the shape and size of the various structures. Calcifications are more distinctly shown.

When there is a completely clear abdomen, the usual form of intravenous urography is quite satisfactory. In cases with myxedema, infections, renal failure, megacolon, or many extraneous gas shadows, tomography has undebatable value.

Seven roentgenograms; 4 diagrams; 1 table.

CHARLES M. NICE, JR., M.D., PH.D.
Tulane University

Multiple Ureteral Diverticula. Patrick A. Dolan and W. E. Kirkpatrick. J. Urol. **83:** 570–571, May 1960. (Jefferson Davis Hospital, Houston, Texas)

Ureteral diverticula of any kind are rare, and multiple ureteral diverticula are almost unheard of. The authors report the case of a 79-year-old man, who complained of frequency, nocturia, and urgency, with difficulty in initiating and stopping the stream. These symptoms were of long standing. The patient had also experienced sporadic occurrences of what was interpreted to be urinary infection. Retrograde pyelography revealed minor irregularity of the upper calyces consistent with pyelonephritis, and trabeculation of the bladder and elevation of its base by an enlarged prostate. Nine bilateral, unevenly spaced ureteral diverticula were demonstrated, each 3 mm. or less in its greatest dimension. The highest lay some 3.5 cm. below the ureteropelvic junction, the lowest some 8 cm. above the ureterovesical junction.

The relative importance of infection, obstruction, and congenital weakness of the ureteral wall in the pathogenesis of diverticula is discussed. The authors are inclined to believe that in their case local congenital weakness of the ureteral wall might have been an important predisposing factor, and that urinary infection played only a secondary role in the causation of the outpouching.

Two roentgenograms.

JOSEPH M. WINSTON, M.D.
University of Pennsylvania

Ureteric Reflux in the Paraplegic. J. Cosbie Ross, Marek Damanski, and Norman Gibbon. Brit. J. Surg. **47:** 636–642, May 1960. (Liverpool Regional Paraplegic Centre, Southport, England)

In 101 patients suffering from traumatic paraplegia, retrograde cysto-urethrography was performed because of persistent retention of urine. In 39 of this number, ureteral reflux was found on one or more occasions, varying widely in degree from case to case. It was bilateral in 22 patients and unilateral in 17. Ureteral reflux was associated more frequently with high than with low

spinal injuries. All patients had persistent retention of urine and catheterization had been unusually prolonged; all had chronic urinary infection. The inflammatory changes in the lower part of the ureter may have played an important part in the development of reflux in these cases.

Hypertonia and trabeculation of the bladder appear to be of great importance and certainly are the most constant findings in persistent reflux. Hypertonia was demonstrated in 23 of the authors' 39 patients; in 19 patients there was a generalized trabeculation of the bladder and in 6 others a localized saccule was demonstrated roentgenographically in the region of one or both ureteric orifices. In an appreciable number of cases some abnormality of the ureteric orifice was noted. In 10 of the authors' patients with reflux there was bilateral, and in 7 unilateral, hydronephrosis. In their experience, reflux has not been responsible for many uremic deaths; it may be responsible, however, for a deterioration of renal function at a time when the intravenous pyelogram is still normal.

More than half of the patients exhibiting reflux in the present series were cured by eliminating obstruction at the bladder neck or at the external sphincter level. If there is gross abnormality of the ureteric orifice, the plastic operation advocated by Hutch (1952) should be tried. The authors emphasize that ureteric reflux should be treated conservatively for a time; if this treatment is not effective, then various surgical procedures may be instituted. It is considered that early elimination of bladder-neck obstruction probably provides the best chance of preventing the development of reflux.

Eleven roentgenograms; 1 diagram; 10 tables.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

The Megacystis Syndrome. Albert J. Paquin, Jr., Victor F. Marshall, and John H. McGovern. J. Urol. **83**: 634–646, May 1960. (James Buchanan Brady Foundation, New York Hospital, New York, N. Y.)

In 1958, D. Innes Williams used the term megacystis to indicate an abnormally large, smooth thin-walled bladder accompanied by vesicoureteral regurgitation and dilated ureters. This combination was seen by him in a number of children with persistent or recurrent urinary infection. The authors have studied 27 patients who were thought to have the megacystis syndrome. Girls predominated over boys in this series by 22 to 5. The mean age of the patients at time of diagnosis was four years, but the age range was one to thirty-seven years. The initial symptoms almost uniformly pointed to urinary infection; all 27 patients had persistent or recurrent pyuria, 22 had frequency, urgency, nocturia, and enuresis; and 22 had had febrile episodes. Surprisingly, 59 per cent also had had abdominal pain. Many of the children were readily toilet trained and later appearance of wetting and enuresis was the first indication of something amiss.

Residual urine in the bladder was measured in 14 cases and was always less than 30 c.c. Cystography was one of the most valuable diagnostic procedures. Vesicoureteral regurgitation was demonstrated in all of the cases, bilateral in 20 and unilateral in 7. A large bladder was definitely more common in the patients in the present series than in normal subjects but was not an invariable finding. The bladders were characteristically thin-walled and smooth. The trigones were almost always two or three times the size expected in a normal child. Since a large trigone was more consistently present than merely a large vesical capacity, the term megatrigone seems more applicable to the syndrome than megacystis. The ureteral orifices were two or three times normal size, and intramural ureteral lengths less than half the normal.

The precise nature and cause of the fundamental anomaly producing the megacystis syndrome are unknown, but the authors feel that it is a congenital deformity which comes to attention because of superimposed complications. They favor the concept of a developmental disproportion in the vesical base generally, with increased trigonal size and shortened, widened intramural ureters being the most recognizable aberrations.

In spite of the uncertain etiology of the megacystis syndrome, definitive surgery was undertaken in all 27 patients, with the best results following reimplantation of the ureter and revision of the vesical outlet. The majority of the patients showed objective improvement when they were examined six months or more postoperatively.

Nineteen roentgenograms accompanied by drawings; 1 diagram; 1 graph; 1 table.

ROBERT E. CAMPBELL, M.D.
University of Pennsylvania

Congenital Bladder Neck Obstruction: Diagnosis by Delayed and Voiding Cystography and Surgical Removal by Use of a New Cold, Crush-Cutting Punch Charles Montgomery Stewart. J. Urol. **83**: 679–681, May 1960. (2010 Wilshire Blvd., Los Angeles 57, Calif.)

The possibility of a congenital obstructive lesion of the lower urinary tract should be considered in a child who has recurrent urinary infections, residual urine, unexplained fever, flank pain, vague abdominal distress, or impaired voiding force. The diagnosis must be made early if progressive, irreparable damage to the upper urinary tract is to be avoided.

The initial diagnostic x-ray procedures of choice are delayed and voiding cystography. The information obtained from cystography often is diagnostically complete and further x-ray studies are unnecessary. When cystography reveals delayed, recurrent, or voiding ureterorenal reflux from obvious bladder neck obstruction, complete, prompt relief must be achieved by one method or another to stop progression of upper urinary tract back-pressure damage. Cystotomy is often the emergency treatment of choice; occasionally, periodic dilatation of the contracted bladder neck will give temporary relief.

During the past four years, at Los Angeles Childrens Hospital, a new suprapubic transvesical, cold, crush-cutting punch has been employed for the surgical treatment of bladder neck obstruction. The author describes the design of the instrument and the technic of its use. In 58 consecutive cases there have been no severe complications except in one instance in which postoperative septicemia caused death from meningitis and peritonitis, forty-eight hours following surgery. Functional results have been uniformly excellent, with either partial or complete regression of upper urinary tract dilatation following the surgical removal of the vesical neck obstruction.

One photograph.

DAVID E. KUHL, M.D.
University of Pennsylvania

THE ADRENALS

Inferior Vena Cavography in Preoperative Localization of Pheochromocytoma. Ronald R. Lund, Nicholas A. Garcia, III, Gilbert A. Le Blanc, C. Gartenlaub, and J. Francis Richardson. J. Urol. **83:** 768–773, May 1960. (U. S. Naval Hospital, St. Albans, N. Y.)

Inferior vena cavography is suggested as a routine diagnostic procedure in localizing established or suspected pheochromocytoma. The authors describe a technic which they have found of particular value because of its simplicity and safety. The patient lies supine on a radiographic table tilted to a 10° Fowler's position. A 3-inch, 17-gauge needle with a 45° bevel is inserted percutaneously into the right femoral vein approximately 1 cm. below the inguinal ligament and just medial to the femoral pulse. After entry into the vein the needle is advanced 2 cm. to diminish the possibility of extravasation. Thirty cubic centimeters of 50 per cent sodium diatrizoate (Hypaque) is rapidly (within four seconds) injected. A lateral exposure is made at the end of injection; after ten minutes, a second injection is made for an anteroposterior view. This view demonstrates the inferior vena cava and the renal collecting system on the same film. Additional pyelograms are obtained at appropriate intervals.

The inferior vena cava traverses the retroperitoneal space and is easily displaced and indented by retroperitoneal tumors arising from the right adrenal or from the chromaffin bodies of the abdominal sympathetic plexus. The left adrenal is not closely related to the vena cava, and tumors at this site would not be easily detected by inferior vena cavography. Since most pheochromocytomas occur in the right adrenal, this disadvantage is somewhat minimized. Positive localization of the tumor is of obvious value to the surgeon; a negative study should direct attention toward the left adrenal region when the presence of pheochromocytoma has been established by pharmacologic tests.

Two cases are reported to illustrate the value of preoperative localization of pheochromocytoma by inferior vena cavography.

Eight roentgenograms; 1 drawing.

R. JACOBS, M.D.
University of Pennsylvania

RADIOTHERAPY

Place of Radiation Therapy in the Treatment of Cancer. R. Kenneth Loeffler. Wisconsin M. J. **59:** 319-328, May 1960. (1300 University Ave., Madison, Wisc.)

At the present time the curative treatment of cancer is largely limited to surgical and radiation measures. Therapeutic radiology, however, is rarely given any time in the undergraduate curriculum, and the aims, technics, and results of the radiotherapist are usually less well appreciated than are those of the surgeon. This paper reports the major part played by irradiation in the treatment of many cancers of the head and neck, skin and breast, uterus, bladder, and testicle, and of the lymphomas. Patients with lesions of the lung, esophagus, kidney, and ovary can frequently receive major benefit from radiotherapy, as well as those with a variety of less common diseases. Palliative treatment offering relief from pain, prevention of bone collapse, and control of infection and hemorrhage can contribute materially to the management of the patient with generalized disease.

Basic and simple radiotherapeutic principles are explained. Differences in absorption between radiations of differing energies are illustrated, and megavoltage is discussed at some length. A case report is given to illustrate one type of natural history of cancer.

Eight roentgenograms; 2 diagrams; 3 graphs.

Radiation Effects of Neutron-Capture Therapy on a Malignant Vascular Neoplasm of the Cerebellum. Histopathological Observations. Stuart W. Lippincott, Y. Lucas Yamamoto, and Lee E. Farr. Arch. Path. **69:** 44–54, January 1960. (Medical Department, Brookhaven National Laboratory, Upton, N. Y.)

The direct radiation effects of energetic heavy particles (alpha and lithium) on tissue following neutron-capture therapy of a malignant vascular neoplasm of the cerebellum are presented. The patient, an eleven-year-old child, was admitted to the hospital in deep coma and completely unresponsive. Nearly eleven months before, a neoplasm of the right cerebellar hemisphere had been found upon suboccipital craniotomy. Extensive postoperative x-ray therapy was ineffective, and the neoplasm gradually grew and extended progressively from the suboccipital area to the right angle of the mandible. Despite the size of the tumor, its failure to respond to x-irradiation, and the patient's desperate condition, neutron-capture therapy was carried out. In this procedure the patient is given an intravenous injection of sodium pentaborate, followed at a predetermined, but short, interval by an exposure to tissue infiltration by thermal neutrons. Following the capture of a thermal neutron by the boron-10 atom, the latter promptly disintegrates into an alpha particle and an energetic lithium atom, with a large release of energy (2.4 Mev). All the energy of the alpha particle and the lithium atom are absorbed within a tissue volume approximately that of one cell. Within three days of this treatment in the authors' case, there was progressive softening of the neoplasm. Since the port employed was not large enough to allow irradiation of all of the neoplasm, a second course of neutron therapy was administered after approximately ten weeks. Eight days later, after a coma of four and a half months, the patient regained consciousness. Three months after the second treatment, at the time of the report, the patient was up in a wheel chair and showing on repeated neurologic examinations a continued return toward normal.

Biopsy specimens from the neoplasm were taken before and at intervals up to ninety-two days after the neutron-capture therapy. The histologic findings are described in detail, and 16 photomicrographs are reproduced.

Radiation in the Management of Keloids and Hypertrophic Scars. H. A. S. Van den Brenk and C. C. J. Minty. Brit. J. Surg. **47:** 595–605, May 1960. (Cancer Institute, Melbourne, Australia)

The authors attempt to elucidate, from clinical and experimental data, the rationale of radiotherapy for keloids and related conditions. They believe that the

dosage régimes advocated by radiotherapists and dermatologists often pay insufficient heed to pathological and radiobiological factors, the natural history of the lesion, and the distinction between specific radiosensitivity of keloid and hypertrophic tissues and nonspecific radiation atrophy. The fact that hypertrophic scars and so-called "keloids" have an inherent tendency toward spontaneous regression can easily lead to the incorrect assumption that regression is due to treatment.

In this paper the authors assess the usefulness of irradiation, with or without surgery, in the management of keloids, based on a series of 147 consecutive cases. In 140 of these patients the keloid followed a definite cause, *i.e.*, surgical incision, an accidental wound, or burn. In only 7 patients was the lesion "spontaneous," with no apparent etiologic factor.

The following conclusions are drawn: (1) Primary irradiation of an established keloid, without surgery, may relieve symptoms such as pruritus, but fails to produce resolution of the actual lesion. If higher doses are employed (1,000 r or more in a single dose), atrophy of the whole irradiated volume may cause partial masking of the keloid. If the dose is sufficiently high to produce radionecrosis, recurrent keloid may result. (2) Irradiation of very recent keloids, which are still cellular, well vascularized, and actively growing, may cause some resolution of the lesion, *if* a dose in excess of 1,000 r is given in a single application. Any resolution following less than 1,000 r is accounted for largely by natural regression of the lesion. (3) Preoperative irradiation is open to the objections (*a*) that the volume irradiated must necessarily be large enough to ensure coverage of the entire surgical wound and (*b*) that the rapid recovery from radiation effects of tissues capable of repair readily gives rise to superregeneration and recurrence. (4) Postoperative irradiation administered *before* the repair blastema and epithelial tissues have grown sufficiently to establish a recurrent hypertrophic thickening is the most efficient radiation technic for prevention of recurrent hypertrophic scars and keloids. The dose employed must lie between 1,000 and 1,500 r in a single application. This dose invariably causes atrophy of cutaneous tissues, which is often unsightly and, if sufficiently widespread, may be subject to radionecrosis. Preferably, the radiation should be given within forty-eight hours of surgery, to an accurately approximated wound, with a margin of 0.5 cm. of normal skin. (6) Owing to the rapidity of tissue regeneration, fractionation of dose should not be employed. (7) The possibility of damage radiation to growing bones in young children, even with a minimal dose, must be kept in mind.

Twenty-three photographs in color illustrating the response of keloids to irradiation; 18 photomicrographs; 2 photographs in black and white; 2 graphs; 5 tables.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Carcinoma of the Oral Cavity. Parts I and II. John H. Lamb and Dwane B. Minor. Minnesota Med. **43:** 90–96, February 1960; 172–176, March 1960. (117 N. Broadway, Oklahoma City 2, Okla.)

The authors saw 783 oral cancers between 1944 and 1959. The first part of their report deals with the pathology, etiology, and location of these lesions; Part II deals with therapy.

In the authors' experience, radium combined with roentgen rays in treating carcinoma of the mouth results in the highest possible number of cures with the lowest number of sequels and recurrences. It is known that through the years a combined x-ray and radium dosage of well over 11,000 r has been delivered to some areas, but when a cure is accomplished the tumor has received at least a lethal dose of 7,000 combined r *in all areas*. The mucous membranes of the mouth can safely take a dose of 12,000 r with a combination of roentgen rays and radium. Details of technic are given.

An exhaustive study of the 54 patients treated in the 1949–54 period and of the results was made. A résumé of the therapy given in these cases shows:

Method of Treatment	*No. of Patients*
Interstitial needles only	1
Interstitial needles + coned filtered x-ray + radium intraoral pack	2
Interstitial needles + coned filtered x-ray	5
Interstitial needles + coned filtered x-ray + external x-ray	19
Intraoral radium pack and diathermic removal	2
External filtered x-ray + coned filtered x-ray	4
Interstitial needles + coned filtered x-ray + external filtered x-ray + intraoral radium pack	12
Radium intraoral pack + coned filtered x-ray + external filtered x-ray	6
Intraoral radium pack + external filtered x-ray	3
TOTAL	54

There were 37 five-year cures (68.3 per cent), with 2 subsequent deaths from oral cancer; 1 four-year cure; 1 three-year cure; 14 deaths from oral cancer. One patient was lost to follow-up.

In only 4 of the 14 patients who died of oral cancer were interstitial radium element needles used. Two of these 4 were clinically well five years after treatment but had a new oral growth in another location which was not cured by irradiation. The remaining 10 patients were treated in conjunction with other physicians, and other methods, such as surgery and radon seed implantations, had been employed before the patients were seen by the authors. In 8 cases the size and location of the lesion made employment of interstitial needles impossible.

Four photographs; 3 tables.

Electron-Beam Therapy of Malignant Tumors of the Mouth and Jaw. Friedhelm Oberheuser, Gerhard Schubert, Karl Schuchardt, and Bernhard Spiessl. Strahlentherapie **112:** 17–23, May 1960. (In German) (Universitäts-Frauenklinik, Hamburg-Eppendorf, Germany)

Radical surgical procedures for cancer of the mouth and jaws have contributed to improved survival rates. Their disadvantages, however, are extensive mutilation and a high surgical risk, especially in elderly patients with lowered vitality. Orthovoltage therapy has been of limited benefit.

Electron-beam therapy now appears superior to the older methods. With the 15-Mev betatron penetration of the electrons can be regulated to a depth of 8 cm.

The deeper tissues remain intact, and the skin, bone, and cartilage are spared in spite of large tumor doses. A total dose of 5,000 r is well tolerated as long as no more than 300 r are applied daily to each field. Although the betatron equipment has been used for over ten years, very large doses have only recently been attempted.

Two cases of far-advanced squamous-cell carcinoma of the mouth are briefly reported, in which rapid regression of the tumor followed electron-beam therapy.

At the time of this report, only 40 cases had been subjected to this new form of therapy. The material is too small and the time lapse too short for a statistical evaluation. The results, however, are encouraging, and it is felt that a combination of electron-beam therapy with conservative surgical measures can now be recommended for less advanced cancers of the oral cavity, jaws, and nasal sinuses.

Four photographs; 2 drawings; 1 table.

ERNEST KRAFT, M.D.
Northport, N. Y.

The Management of Early Breast Cancer. T. H. Ackland, W. P. Holman, and B. A. Stoll. M. J. Australia 1: 793–798, May 21, 1960. (Peter MacCallum Clinic, Melbourne, Australia)

The authors attempt "to assess without prejudice the relative places of surgery and radiotherapy in the treatment of potentially curable breast cancer." Much useful background material, including statistics from other reports, is given. The paper is recommended in its full form to those desiring basic information on current philosophy and methods of treatment of early breast cancer.

On the basis of their own experience, a number of conclusions are drawn. The criteria for the performance of radical mastectomy should be stricter and more rigidly applied than they have been in the past. It is pointed out that there is a wide variation in the percentage of positive axillary nodes in various series, indicating a wide latitude in the application of criteria for operability. The disease is almost always more advanced than it appears, and an estimation of its extent by clinical means must remain crude. In this connection the authors recommend surgical exposure of the apex of the axilla and its inspection as a simple preliminary to radical mastectomy in doubtful cases. Extended radical mastectomy (exposure and block excision of internal mammary vessels and nodes and adjacent rib structures as described by Urban) should receive serious consideration in cases of early *medial quadrant* carcinoma in young subjects in good health.

Radiotherapy, almost always administered postoperatively rather than preoperatively, must be based on the necessity for reaching a critical radical dose level and is "best confined to the surgically untreated but vulnerable lymphatic drainage areas, that is, the apex of the axilla, the supraclavicular draining areas and the internal mammary draining areas." The authors' methods of delivering what they consider to be meaningful doses of radiation to these areas are described, but the actual details of technic are not given. Particular attention is paid to the internal mammary chain, which is irradiated through two oblique, narrow rectangular fields, with cross-firing of the tissues beneath the sternum. In the usual case, the skin flaps over the chest wall are not irradiated.

The authors feel that radical surgery followed by radiotherapy remains the treatment of choice for Stage I and Stage II breast cancer. Simple mastectomy has no place in the treatment of potentially curable carcinoma, but is often a useful palliative procedure for slowly growing malignant tumors in elderly patients.

Seven figures.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Value of an Early Change in Hormonal Status through Suspension of Ovarian Function and Application of Androgens in the Therapy of Advanced Mammary Carcinoma. Experiences with Prophylactic X-ray Castration in 284 Patients. Hanno Poppe and Anton Gregl. Strahlentherapie **110:** 16–33, September 1959. (Universitätsklinik Göttingen, Germany)

In 284 premenopausal women with advanced mammary cancer the hormonal status was changed by roentgen castration followed by high doses of androgens. In order to determine the effect of this treatment, a comparison was made with "matched" cases which had not been similarly treated. The "matching" was performed by the Hollerith Division of the Max Planck Society [Hollerith is a popular German statistical system], cases with bone metastases, for example, in one group being matched with cases with similar metastases in the other series. Cases were also matched as to age, original treatment, stage of disease, etc.

The observations indicated that in the cases with roentgen castration and androgen therapy there were a higher survival rate, a longer period without recurrence or metastasis, and a longer course after the appearance of metastases. The prophylactic use of this combined therapy is indicated in advanced carcinoma of the breast.

Six illustrations; 7 tables.

GERHART S. SCHWARZ, M.D.
New York, N. Y.

Giant-Cell Lesions of Bone. Osteoclastoma and Giant-Cell Tumour Variants. Survey of a Radiotherapeutic Series. J. Walter. Clin. Radiol. (J. Fac. Radiologists) **11:** 114–124, April 1960. (Sheffield National Centre for Radiotherapy, Sheffield 10, England)

Some of the diagnostic and therapeutic aspects of 32 cases of giant-cell lesions of bone are discussed. All of the cases were originally referred for treatment bearing the label "osteoclastoma" (giant-cell tumor). Reassessment of the material revealed the following diagnoses:

	No. of Cases
Osteoclastoma	15
Simple cyst	3
Fibrous dysplasia	3
Giant-cell epulis	3
Aneurysmal bone cyst	2
Hyperparathyroidism	2
Benign osteoblastoma	2
Osteochondroma	1
Osteogenic sarcoma	1

Thus, out of the 32 cases, barely half were finally accepted as true osteoclastoma. In 7 of the cases the diagnosis was confirmed histologically

The classical "soap bubble" appearance of osteoclastoma is far less common than formerly believed and may be produced by other lesions. The site of the tumor and the cortical changes are probably of more

diagnostic value, and osteoclastoma can be virtually excluded in a patient younger than eighteen to twenty years.

Surgical resection is probably the best treatment of osteoclastoma, but none of the tumors in the present series were suitable for primary excision. Eleven patients received 200 to 300 kv x-ray therapy, with doses ranging from 2,000 to 4,000 r in two to four weeks. In 1 case 4,350 r was administered in seven weeks, 2,100 r x-ray therapy and 2,250 r by cobalt beam. Cobalt beam therapy was employed alone in 2 cases, 5,100 r in four weeks in 1 patient and 3,000 r in three weeks in the other. One patient received 2 Mev therapy, 3,100 to 3,700 r in four weeks. Supervoltage or gamma-ray beam therapy is preferable to deep x-rays at 200 to 300 kv, since the difference in the energy absorption between soft and bony tissue is considerable with the softer rays. Radiotherapy was followed by surgery in 3 cases. Nine patients are clinically and radiologically well after two to twenty years. Three patients have made good clinical but uncertain radiological progress at two to two and three-fourths years, while in 2 cases amputation was necessary. In the remaining case, amputation was performed immediately after x-ray therapy because of misleading information from a drill biopsy, which was reported as showing sarcoma.

The following giant-cell tumor "variants" are discussed with reference to their radiation treatment: simple cyst and fibrous dysplasia, giant-cell epulis, aneurysmal bone cyst, tumors in hyperparathyroidism, and benign osteoblastoma.

Most patients with aneurysmal bone cyst are younger than twenty years, in contrast to those with osteoclastoma. The 2 cases in the present series responded well to x-ray therapy; the dosage in 1 patient was 2,000 r in thirty-three days, and in the other 2,100 r in eighteen days.

Surgical therapy is preferable to irradiation in simple bone cysts, fibrous dysplasia, and giant-cell epulis. Giant-cell epulis, a lesion of the jawbones, is probably a reparative granuloma rather than a neoplasm. Radiotherapy was effective in the 2 cases of giant-cell epulis in the present series; it is likely that irradiation would not have been used in these cases if the true nature of the lesions had been recognized at the start.

Many of the features of benign osteoblastoma merge into those of ordinary osteoid osteoma and aneurysmal bone cyst. It occurs typically in the first three decades of life, with a high incidence in the spinal column. Although surgical removal or curettage may be more appropriate, in the author's 2 cases radiotherapy was employed, and the results so far have been satisfactory.

Sixteen roentgenograms; 3 photomicrographs.

SAMUEL B. HAVESON, M.D.
Lynwood, Calif.

Radiologic Aspects of Primary Tumors of the Spine and Their Treatment; 40 Cases. J. Legré and G. Serratrice. J. de radiol. **41:** 217–229, May 1960. (In French) (Marseille, France)

A series of 40 primary tumors of the spine constitutes the basis of the present work. The tumors are classified according to the tissues of origin as follows: (1) tumors from skeletogenetic tissues, including osteochondrosarcomas, chondromas, and osteomas and periosteal lipomas and fibromas; (2) tumors from reticulogenetic tissues, as reticulosarcoma or Ewing's sarcoma and plasmacytoma; (3) tumors of vascular connective tissues, as angiomas, myeloma, and aneurysmal bone cysts; (4) vestigial chordoma.

The radiologic appearances of these tumors and their treatment are discussed. Radiotherapy may be of value in angiomas, giant-cell tumors, and reticulum-cell sarcoma and possibly has some palliative effect in certain cases of metastatic cancer. Combined surgical and radiation therapy is quite useful, especially when a decompression laminectomy is performed first. There are probably more favorable long-term results with the combined procedures in tumors of a relatively benign type.

CHARLES M. NICE, JR., M.D., PH.D.
Tulane University

Betatron Therapy of Gynecologic Cancers. Gerhard Schubert, Hans-Joachim Schmermund, and Friedhelm Oberheuser. Strahlentherapie **112:** 4–16, May 1960. (In German) (Universitäts-Frauenklinik, Hamburg-Eppendorf, Germany)

The authors report on a series of 347 women with gynecologic cancer, treated with the 15-Mev betatron at the University Gynecologic Clinic in Hamburg-Eppendorf. In 187 cases treatment was with ultrahard roentgen rays, and in 160 with fast electrons. From experimental biological observations, the high-energy roentgen rays appear to be slightly less effective than orthovoltage rays, for the same output of roentgens, but the depth dose is much higher. At a depth of 16 cm. it still is 120 per cent of the skin dose against 30 per cent with 200 kvp. This factor explains the superiority of betatron therapy in obese patients with intra-abdominal masses.

With the electron beam at 15 Mev, the effective dose at 5 cm. depth is 80 per cent of the skin dose. It rapidly decreases, however, beyond this point so that at a depth of 8 cm. practically no ionization takes place. Therefore, more superficial lesions were selected for this form of therapy, 43 patients with primary and/or recurrent breast tumors, 52 with carcinoma of the vulva, and 65 with malignant tumors in other locations. For vulvar carcinoma the total dose was gradually increased to 6,000 r per field, with single daily doses of 300 r, the beam being either stationary or rotational. A 70 per cent one-year survival was obtained in advanced carcinoma of the vulva, which indicates a great improvement over previous series.

Ultrahard-wave betatron therapy was used in 187 cases. In a series of 33 patients with far advanced carcinoma of the cervix 79 per cent had no recurrence in more than a year as against 66 per cent in a comparable group of 103 patients treated with orthovoltage rays. Megavolt therapy is much better tolerated and it results in less skin damage, especially in the obese patient. The total dose was 5,500 r to each of four parametrial fields with a daily dose of 200 r. Supplementary intrauterine radium also was applied for the primary tumor. Five-year results are not yet available.

Four photographs; 5 tables; 6 isodose curves; 2 graphs; 1 drawing.

ERNEST KRAFT, M.D.
Northport, N. Y.

Adenocarcinoma of the Uterine Cervix. Dietrich Buttenberg. Strahlentherapie **112:** 45–53, May 1960. (In German) Universitäts-Frauenklinik Heidelberg, Germany)

Adenocarcinoma of the uterine cervix is relatively rare in contrast to the squamous-cell variety. In the Gynecologic Clinic of the University of Heidelberg 105

cases were encountered between 1935 and 1953, constituting 5.5 per cent of all cervical cancers seen in that period. This number included 7 carcinomas of Gartner's duct.

Because of its predominantly high position, cervical adenocarcinoma produces few symptoms and easily escapes detection. Nor is its recognition simple from the gross pathologic appearance or location; even histologically it may simulate atypical squamous-cell cancer. It is more malignant than the latter type, and lymphatic as well as hematogenous spread occurs relatively early.

Cervical adenocarcinoma is less radiosensitive than squamous-cell carcinoma and therefore requires more intensive radiotherapy. Of the author's cases, 89 were treated by irradiation and 13 by surgery. Postoperative roentgen therapy was done routinely, even after the radical Wertheim operation, each of four fields receiving 2,400 r. In the cases treated by irradiation alone, the intrauterine radium dose was 10 to 20 per cent higher than in squamous-cell cancer. Recently, all cases with parametrial involvement have had teleradiocobalt therapy.

The cure rate in this series was only 37.1 per cent against 48 per cent in a comparable series of squamous-cell carcinoma. The less favorable result is attributed to (1) more advanced age of the patient, (2) more rapid spread, and (3) greater radioresistance.

Six photomicrographs; 1 graph; 3 tables.

ERNEST KRAFT, M.D.
Northport, N. Y.

Cytologic Prognosis in Cancer of the Cervix. Ruth M. Graham. Am. J. Obst. & Gynec. **79:** 700–703, April 1960. (Roswell Park Memorial Institute, Buffalo, N. Y.)

The author cites the 54.6 per cent five-year salvage reported by Brunschwig and Daniel for the surgical treatment of carcinoma of the cervix and the 53.7 per cent five-year salvage obtained during the same period at the Roswell Park Memorial Institute by radiotherapy. Studies of the vaginal secretions on patients with carcinoma of the cervix are presented in an attempt to answer the question "Does any cellular factor correlate with the eventual outcome and the mode of therapy?"

There was a distinct difference in the amount of inflammatory cells in the vaginal secretion seen in patients with the same extent of disease. When the proportion of histiocytes to benign squamous epithelial cells was more than 50 per cent, the five-year survival was 24 of 38 patients (63 per cent) treated by radiotherapy. When the histiocyte count was less than 50 per cent, irradiation produced a five-year survival of 15 of 62 patients (24 per cent). Of 66 patients treated by surgery, 62 had low histiocyte counts with 84 per cent salvage; of the 4 patients with high histiocyte counts surgically treated, only 1 survived.

Superficial cell counts of the vaginal secretions were done to estimate the amount of estrogen present. A 20 per cent patient survival resulted with treatment by irradiation when the percentage of superficial cells was 70 per cent. With 70 per cent superficial cells there was 85 per cent survival for patients treated by surgery.

With poor sensitization response (SR), 68 of 99 patients (69 per cent) treated surgically had five-year survival; 16 of 65 similar patients (25 per cent) treated by radiation survived for five years. With good sensitization response, surgery produced 43 per cent (13 of 30) and radiation produced 72 per cent (31 of 43) five-year survivals.

Considering either the amount of inflammatory cells present, the height of the estrin effect, or the sensitization response, the survival curves took opposite directions with the two methods of treatment. This indicated that surgery and irradiation are not curing the same cases.

Dr. Michael J. Jordan (New York), in discussing the paper, pointed out that Guttmann and Kottmeier, independently, without regard for sensitization response, radiation response, histiocyte count, or estrin effect, had five-year survival figures after irradiation of Stage I cases of 89.5 and 85 per cent, respectively. It appeared to him illogical to assume that the majority of patients with carcinoma of the cervix will do well with only one modality.

Three figures; 1 table. ROBERT L. EGAN, M.D.
University of Texas, Houston

Primary Carcinoma of the Vagina. G. H. Arronet, J. P. A. Latour, and P. C. Tremblay. Am. J. Obst. & Gynec. **79:** 455–460, March 1960. (Royal Victoria Hospital, Montreal, Quebec, Canada)

This report consists of an analysis of 25 cases of primary carcinoma of the vagina seen at the Royal Victoria Montreal Maternity Hospital during the years 1926 to 1958; all patients were actively treated and none was lost to follow-up. These 25 vaginal carcinomas accounted for 1.2 per cent of 2,235 primary cancers of the female genital tract encountered during that period.

The youngest patient in the authors' series was thirty-five while the oldest was sixty-seven, the average age being 50.2 years. Twenty-two patients were married; 6 were nulliparous. Nineteen patients were menopausal, while 6 were still menstruating. Only 3 patients had a systemic disease (1 had diabetes; 2 had a record of positive serological reactions). No inciting cause of the carcinoma was detected. Obvious lesions were noted by 15 patients. Spontaneous bleeding was the presenting complaint in 17 patients and local pain in 6. The majority of the patients had symptoms of less than six months duration, while 2 had symptoms for more than two years.

The primary site of origin was the upper third of the vagina in 57.7 per cent of the series and the posterior wall in 53.8 per cent. In 9 cases the tumor was unicentric and in 4 it was multicentric; in the remaining 12 cases either this information was not given or the lesion was widespread. Eleven of the tumors were ulcerative, 6 were fungating, and 2 were both ulcerative and fungating; 6 cases lacked sufficient description to be classified. Six tumors measured from 1 to 3 cm. in diameter, 16 measured over 3 cm. in diameter; in 3 cases the size of the tumor was not specified. All of the tumors were of the epidermoid variety except 1, which was classified as a transitional-cell carcinoma, possibly originating in a Gartner's duct.

Radical surgery was performed in only 1 patient; all others received radiotherapy, with various dosages of radium and x-rays and different radium applicators. The five-year survival rate was 44 per cent. The standard cervix radium dose was 6,000 mg. hr. in divided doses. Nine patients were treated with a substandard radium dose—between 2,100 and 4,500 mg. hr.; in this group there were 7 five-year survivors. Of 2 patients receiving a standard radiation dose, 1 survived five years. Central linear sources of radium,

with a surface dose of 4,800 to 9,000 r, were employed in 3 patients, with 2 five-year survivors. Radium, in a cervix-type applicator, in a substandard dose, plus x-ray therapy (3,000 to 9,000 r) resulted in no five-year survivals among 8 patients.

The value of staging the tumor is discussed.

[This is a concise and detailed report of a relatively large series of a rare cancer of the female genital tract which is amenable to cure by radium applications.—R. L. E.]

Five tables.

ROBERT L. EGAN, M.D.
University of Texas, Houston

Dysgerminoma of the Ovary: Unusual Roentgen Manifestation of Metastases. S. R. Feinberg. Minnesota Med. **43:** 179–181, March 1960. (737 East 22d St., Minneapolis 4, Minn.)

A large pelvic dysgerminoma is reported in a 17-year-old girl. Clinically, a smoothly marginated mass rose centrally from the pelvis and extended to the subxiphoid level. There was a classical "bull neck," as described in Hodgkin's disease. Roentgenograms showed a massive superior mediastinal adenopathy and a pelvic mass, with retroperitoneal lymph node involvement manifested by ureteral displacement on the excretory urogram. Node biopsy showed dysgerminoma and the pelvic mass was surgically removed to facilitate radiation therapy.

Radiation with a h.v.l. of 2.8 mm. Cu was given to the pelvis, periaortic bed, mediastinum, and cervical regions. The tissue dose varied between 600 and 1,000 r. The course of treatment was regulated by the white cell count, which fell to the 1,000 range, and the hemoglobin, which dropped to 3 or 4 gm. No masses were palpable after therapy, and the chest returned to normal roentgenographically.

The patient was able to carry on a normal life during the next two and three-quarters years in spite of multiple metastases, all of which responded to minimal doses of irradiation. Of particular interest were subcutaneous metastases, giving the clinical appearance of edema, and "sun-ray" changes indicative of new bone formation in the cranial vault. The last visits to the hospital were prompted by a painful hip. Actually there was pathological fracture through a generalized bone change, pagetoid in appearance, involving pelvis, hips, and femurs. These zones showed marked demineralization, accentuation of the primary trabeculae, bowing of the femoral necks, and broadening of the femurs with some periosteal proliferation.

Seven roentgenograms.

Artificial Menopause with the Aid of Ionizing Rays. Alfred Kratochwil, Hans Lehrner, and Edmund Schüller. Strahlentherapie **112:** 63–69, May 1960. (In German) (II. Universitäts-Frauenklinik, Vienna, Austria)

In the authors' clinic, since 1933, a radiation-induced menopause has been achieved in 1,314 cases, for the most part by external roentgen irradiation, with an ovarian dose of 200 to 250 r. Indications were preclimacteric metrorrhagia and, to a lesser extent, myomatous enlargement of the uterus. Development of carcinoma of genital organs later on was observed in only 1.5 per cent. This low incidence is probably merely coincidental and unrelated to the preceding castration dose.

Surgical castration is given preference only in breast cancer. Oophorectomy was done prophylactically following mastectomy in 57 cases. Here, the amazing observation was made that in 17.5 per cent unsuspected small metastatic deposits were already present in one or both ovaries. In a few the seeding was so minute as to be visible only microscopically. These observations are confirmed in other series in which the frequency of unsuspected metastatic spread to the ovaries has been reported as high as 29.5 per cent. For this reason it is recommended that oophorectomy be performed routinely after mastectomy and not limited to advanced cases with recurrence or visible metastatic spread. With roentgen castration, the small but ominous ovarian lesions would have remained undetected, and important information would be missing from a prognostic standpoint.

One table.

ERNEST KRAFT, M.D.
Northport, N. Y.

Eosinophilic Granuloma of the Bladder. Edwin W. Brown. J. Urol. **83:** 665–668, May 1960. (1925 N. Flagler Drive, West Palm Beach, Fla.)

The author presents a case of eosinophilic granuloma of the bladder, which is believed to be the first recorded in the literature. Theories of the etiology of the condition are discussed, including the possible relationship to lymphoblastoma and Hodgkin's disease, inflammation, and to the lipoidoses.

The author's patient was a fifty-year-old white woman with dysuria, frequency, burning, and suprapubic pain of three weeks duration. Four days before admission she noticed gross hematuria. An intravenous pyelogram was normal. Cystoscopy disclosed multiple yellowish, slightly elevated, plaque-like lesions. Upon coagulation, these lesions seemed to melt and disappear. The patient was treated by Furadantin, Triamcinolone, and Sparine, with minimal improvement. X-ray therapy was administered, for an estimated 2,000 r to the bladder. ACTH was given daily for five days. In the following months the patient showed progressive improvement, but follow-up has been too short to determine whether the x-ray therapy has been effective.

An analysis of the results of various forms of treatment employed in 48 cases of eosinophilic granuloma is presented in tabular form.

S. DAVID ROCKOFF, M.D.
University of Pennsylvania

Chronic Myeloid Leukaemia: A Study of 116 Cases. Sandhya Ghose and J. B. Chatterjea. J. Indian M. A. **34:** 381–387, May 16, 1960. (School of Tropical Medicine, Calcutta, India)

During the ten years prior to this report, 116 cases of chronic myeloid leukemia, the commonest type of leukemia in Indians, were investigated and treated in the School of Tropical Medicine, Calcutta, India. The largest number of cases was in the age group of twenty-three to thirty-two years; the series included 3 children under twelve and the oldest patient was eighty-two. Diabetes mellitus and pulmonary tuberculosis were each associated with the disease 3 times and tuberculous lymphadenitis once. Of 43 females of child-bearing age, 3 conceived during the period of observation, 2 while in states of remission. The deliveries and the children were normal in all 3 cases. A significantly large number of cases occurred in the poorer economic group.

Urethane, Myleran, and deep x-ray therapy were

administered to 109 patients, either singly or in combination. A comparative study on the relative merits of these agents was made on the basis of the patients receiving only one form of treatment. In this selected group, 6 received urethane, 12 deep x-ray irradiation, and 23 Myleran. From the point of view of tolerance and response to therapy, urethane appeared definitely inferior to the other two. Response to x-rays and Myleran seemed to be more or less similar.

It is concluded that chronic myeloid leukemia, like other forms of the disease, is still incurable, but with judicious application of radiotherapy and/or Myleran, worthwhile remissions are obtainable in the vast majority of cases. That patients under controlled therapy can lead useful lives has been amply proved, although it is doubtful whether absolute life span has been increased. Myleran remains the best chemotherapeutic drug so far available. It continues to be a close rival of deep x-ray therapy but is not likely to replace it. Until a better drug is available, the specific treatment would be splenic irradiation and/or Myleran, employed one after the other as necessary.

On the Adequacy of Half-Value Layer as a Criterion of X-Ray Quality in the Calibration of Dosemeters. N. M. Procter and J. R. Greening. Brit. J. Radiol. **33**: 321–325, May 1960. (Medical Physics Unit, Edinburgh University, Edinburgh, Scotland)

The view is widely held that if the response of a thimble ionization chamber is checked against that of a standard free-air chamber, there may be a significant difference in the correction to be applied to the thimble chamber dosimeter readings for beams having the same half-value layer but produced at different combinations of voltage and filtration. Such a difference would mean that a dosimeter calibrated by a standardizing laboratory in a beam of one voltage and half-value layer would no longer be accurately calibrated when used in clinical practice, with a beam of the same half-value layer but different voltage and filtration. The authors have compared 5 thimble chambers with a free-air chamber, using x-rays produced at 20 to 55 kv, with half-value layers between 0.05 and 0.20 mm. Al. Under strictly controlled conditions, the chamber being tested was exposed simultaneously with a free-air chamber.

The results showed that, contrary to expectations, there is very little difference in the response of a well made thimble chamber when it is exposed to radiations of the same half-value layer but produced at different voltages and filtrations. As a consequence, it appears that the differences between x-ray beams used in standardizing laboratories and those employed in clinical practice are less important than had been feared. One of the chambers tested showed a difference of nearly 4 per cent in its correction factor for beams of the same half-value layer produced at 20 and 55 kv. With this single exception the half-value layer appeared to be an adequate criterion of x-ray quality for the calibration of ionization chambers.

Eight figures.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Organization of Radiotherapeutic Service for the [Russian] Population. E. I. Vorobiev. M. Radiol., Moscow **5**: 3–10, May 1960. (In Russian)

Radiotherapy in the U.S.S.R. is now administered to 70 per cent of cancer patients, and radioactive isotopes are available in nearly 200 oncological centers, hospitals, and dispensaries, as well as in 123 educational and research institutes. A broad plan to expand this service between 1960 and 1965 calls for the training of 300 radiation physicists, 2,000 radiotherapists, and 9,000 medical workers, and instruction of technicians for three months by radiation physicists. A Department of Radiological Apparatus has been established and is charged with the development of scintillation counters, protective shields, aprons, safes, radiologically protected sterilizers, gynecological tables, and hand manipulators for isotopes. Tools of the radiologist will include rotational apparatus, linear accelerators of 5 Mev (with a few of 15 to 30 Mev for large institutions), and cesium sources. Neutron therapy and tumor trophic substances will be studied in some large centers.

The Ministry of Public Health, beginning in 1960, is promulgating methodical instruction in the use of radioactive sources, dosimetry, and radiation safety. Engineering groups will be designated to erect special buildings and secure isotopes. Three-month courses in isotope diagnosis and therapy will be offered to experienced radiologists, surgeons, and gynecologists and five-month courses to other physicians, as well as annual conferences for field workers.

B. ABRAMSON, M.D., and F. RIEBEL, M.D.
Columbus, Ohio

RADIOISOTOPES

A Comparison of the 15-Minute Continuous Thyroid Uptake Test with Other Radioiodine Tests. N. Howard, E. O. Field, and G. M. Dyche. Brit. J. Radiol. **33**: 316–320, May 1960. (Royal Marsden Hospital, London, S. W. 3, England)

The results of the 15-minute continuous thyroid uptake test were compared with those of the 2-hour and 24-hour thyroid uptake test and the 0-24-hour urinary I^{131} excretion test in 96 patients. Fifty-five of the group were clinically euthyroid, 14 were hypothyroid, and 27 were hyperthyroid; the great majority had malignant tumors (of the thyroid or of other organs). Only a few patients were less than forty-five years of age.

The scintillation counting was done at 25 cm. from the surface of the neck, using 1 mm. brass plus 1 mm. lead filtration. A ratemeter was employed for continuous counting. The corrected count rates at various time intervals were expressed as the per cent (H) of the count rate of the total dose administered. The normal ranges of the indices ($H_{10\ min.} - H_{1\ min.}$) and ($H_{15\ min.} - H_{5\ min.}$) were -0.25 to $+ 3.0$ and 0.05 to 2.75, respectively.

In thyrotoxicosis, the 15-minute continuous and the 2-hour uptake tests were equally accurate, with a 5 to 7 per cent error; the error for the 24-hour uptake test was 10 per cent. In myxedema, the 24-hour uptake test was most accurate and the 15-minute continuous test the least accurate. The 0–24-hour urinary excretion test was the least reliable of all the radioiodine tests.

The authors conclude that the 15-minute continuous uptake test may be valuable for distinguishing hyperthyroidism, particularly in those clinics where large numbers of patients are seen and where speed is an advantage. For other thyroid diseases and to assess thyroid function in other conditions, the continuous uptake test has no advantage over the 2-hour and 24-

hour tests. The continuous thyroid uptake test is of little value in a hospital where the majority of patients are seen with cancer.

Three figures; 2 tables.

PHILIP M. JOHNSON, M.D.
Montclair, N. J.

Clinical Assessment of Intestinal Fat-Absorption Using Radioactive Fat. W. F. Walker, W. K. Stewart, H. G. Morgan, and J. McKie. Brit. M. J. **1**: 1403–1406, May 7, 1960. (Queen's College, Dundee, Scotland)

Olive oil labeled with I^{131} was given orally to 6 patients with steatorrhea and to 32 asymptomatic adult controls to assess the fat-absorption as reflected in the I^{131} concentrations in the plasma and urine. The plasma concentration of the radioiodine was measured at two, four, six, and nine hours, and the fraction excreted in the urine was determined daily for several days.

In agreement with other investigators, the authors found the maximum concentration of radioiodine in the plasma occurred at about six hours. At this time the mean specific activity of the normal group was about six times that of the abnormals, but in both groups results were so widely scattered about the mean that there was an appreciable overlap. On the basis of the twenty-four-hour urine excretion, the normal group was clearly separated from the abnormals. In the normal group this excretion never fell below 30 per cent, and in the abnormal group it was never greater than 20 per cent. The series is admittedly small, but the results suggest that the criterion for detection of steatorrhea should be excretion in the urine of less than about 25 per cent of the administered activity during the first twenty-four hours.

Further investigation of the reliability of the twenty-four-hour excretion of radioiodine is now being investigated in a larger series, with an administered dose as low as 1 μc.

Five graphs; 2 tables.

DAVID FOXMAN, M.D.
Cleveland Metropolitan General Hospital

A Clinical Evaluation of the Radioactive Diodrast Renogram as a Screening Test in Hypertension. Ralph A. Straffon and Antonio M. Garcia. J. Urol. **83**: 774–781, May 1960. (A.M.G., University of Michigan Medical School, Ann Arbor, Mich.)

The radioactive Diodrast renogram is employed to study simultaneously the function of both kidneys. The procedure was developed by Taplin *et al.* (J. Lab. & Clin. Med. **48**: 886, 1956. Abst. in Radiology **69**: 632, 1957) and is based on the continuous measurement of the uptake and excretion of I^{131}-tagged Diodrast with a gamma-ray scintillation counter over each renal area. The purpose of the present investigation was to evaluate the clinical usefulness and accuracy of such a test in screening hypertensive patients for unilateral renal disease. The authors describe the general procedure and the equipment, which consists primarily of two gamma-ray scintillation counters. The Diodrast is injected intravenously, in a dose of 1 mc per 3 kg. of body weight.

All 200 hypertensive patients studied had the renogram incorporated into their medical evaluation, which usually included pyelography, renal function tests, special tests for pheochromocytoma, and serum potassium determinations. In patients suspected of having unilateral renal disease, aortography and split-function tests were also performed. The results reported here are based on the first 150 patients examined.

In 61 patients, *normal renograms* were obtained. The correlation of the renogram and renal function in this group of patients was exceedingly good. All but 5 patients had had normal pyelograms. The normal renogram may be divided into three segments: Segment A represents the initial sharp rise in radioactivity over the renal area following the intravenous injection of the radioactive Diodrast, and the height of the vascular spike is relative to the vascularity of the area. Segment B represents the renal handling of the Diodrast both by glomerular filtration and by tubular excretion. Segment C represents the clearing of Diodrast from the renal pelvis down the ureters and into the bladder.

Bilateral abnormal renograms were obtained in 42 patients. Twenty-three of these had normal pyelograms and 14 abnormal pyelograms; in 5 cases pyelography had not been performed. Only 3 of the patients with normal pyelograms had normal renal function, while the remainder had various degrees of renal insufficiency, yet sufficient function to permit visualization on the pyelogram. The abnormalities seen on pyelography included hydronephrosis, polycystic renal disease, nephrolithiasis, and chronic pyelonephritis.

Forty-seven patients had *unilateral abnormal renograms*. Since the patients in this group had been suspected of having unilateral renal disease, a more careful and detailed evaluation of the results was made. Normal intravenous pyelograms had been obtained in 26 patients and a unilateral abnormal pyelogram in 21. In the group with a unilateral *abnormal* pyelogram and renogram, there was excellent correlation between the renogram, the pyelogram, and the total renal function. Four of the patients with a unilateral abnormal renogram and *normal* pyelogram exhibited a decrease in the vascular spike (Segment A) only. Six patients had normal vascular spikes (Segment A) and decreased excretory segments (Segment B); all had normal renal function according to accepted clinical methods of evaluation. Sixteen patients had both a decrease in vascular spike and excretory segment, and again all of these patients had good renal function in addition to normal pyelograms.

Despite the fact that the present series is too small for any statistically significant conclusion, the authors believe that the renogram is a useful screening test for unilateral renal disease in patients with hypertension. In their experience, bilateral normal renograms have indicated bilateral normal renal function and vascularity. In the group with bilateral abnormal renograms, there were no known instances of unilateral lesions which could be corrected surgically. The patients with unilateral abnormal renograms should be extensively investigated to evaluate the possibility that a renal lesion may exist which may be corrected surgically, with relief of the hypertension.

Six roentgenograms; 5 renograms; 3 tables.

MIGUEL CHIAPPORI, M.D.
University of Pennsylvania

Hepatography and the Study of the Liver Function by Means of I^{131} Tagged Rose Bengal. D. Ziliotto. Panminerva med. **2**: 217–219, May 1960. (Istituto di patologia medica, Padua, Italy)

The use of I^{131}-tagged rose bengal in examination of

the liver and biliary tract makes it possible (1) to measure the time of clearance of the coloring matter from the plasma either from blood samples or by means of radioactivity readings on the surface of the body in highly vascularized areas; (2) to follow, by means of radioactivity readings over the area of the liver, the "passage" of the coloring matter through the liver itself; (3) to achieve, by scintillation counting, an anatomical and functional picture of the liver which will offer useful clues for diagnosis; (4) to administer small quantities of rose bengal which cannot cause any difficulties even in cases of jaundice.

In the author's first experiments, hepatography was carried out simultaneously with the tracing of the curve of the liver excretion findings and the time of "depuration" of the coloring matter from the blood [by time of "depuration" the author means the time needed for reduction of the circulating activity by 50 per cent]. A dose of I^{131}-tagged rose bengal equivalent to about 500 μc of radioactivity, diluted in 5 c.c. of saline solution, was injected intravenously into 10 patients with normal hepatic function and into 4 suffering from serious liver complaints (cirrhosis and metastatic neoplasms). The technic is given in detail. For functional tests alone, radiation doses of 20 to 25 μc are sufficient.

While the first results do not permit judgment as to the effectiveness of this method, they do show that a double set of tests can be carried out: one strictly functional and one morphologic (hepatographic). It would seem that the introduction of I^{131}-tagged rose bengal into clinical practice offers investigators an excellent means of examination which promises interesting results in the fields of hepatic symptomatology and physiopathology. It can be used without the fear that immediate or long-term injury may result.

Amniotic Circulation Studied with I^{132}. M. Cottafavi and P. Mentasti. Panminerva med. **2:** 220–222, May 1960. (Via Dante 24, Vercelli, Italy)

In the field of obstetrics, the use of radioactive iodine (I^{131}) has been limited by the possibility of damage to the fetal thyroid. I^{132}, however, has such a short half-life (2.33 hours) that it was considered to be free from this danger. It was used by the authors in the study of the amniotic fluids of 9 women: 5 at term, 1 thirty days beyond term, and 3 in whom the fetus had been dead four, six, and thirty days, respectively. A transabdominal puncture of the amniotic membrane was carried out and, after samples of 10 c.c. of blood and of 5 c.c. of amniotic fluid were taken, a dose of 80 to 100 microcuries of I^{132} was given orally. Further samples of blood and amniotic fluid were then obtained every five to ten minutes during the first half hour and subsequently every thirty minutes for periods varying from one to four hours. It is estimated that the radiation delivered to the fetus was less than one-tenth of the amount received in a standard radiographic study of the pregnant uterus.

I^{132} appeared in the blood almost immediately after its administration, and the amount increased rapidly, reaching its maximum in fifteen to thirty minutes. The passage of the radioactive element into the amniotic fluid was also rapid: traces were seen fifteen to twenty minutes after administration and gradually increased even when the isotopes in the mother's blood were diminishing. No leveling of the values in the two divisions was noted in these cases.

The results in the 3 cases of intrauterine death did not differ substantially from those where the fetus was living. This study confirms, then, that the death of the fetus and the consequent curtailing of the uteroplacental circulation do not completely interrupt the materno-amniotic exchanges. These results support the theory that there exists an amniotic circulation directly through the membranes in the materno-amniotic direction. Even in the case of a living fetus the presence of radioactive iodine in the amniotic fluid may be attributed to its passage through the membranes. It is to be remembered, therefore, that the death of the fetus does not necessarily have an immediate effect on the trophism and the functioning of the membranes and that, at least at first, substances continue to pass through them regularly. Only subsequently does passive diffusion taken place.

Two graphs.

Physical Aspects of Cobalt 60 Teletherapy Using Wedge Filters. I. Physical Investigations. II. Dosimetric Considerations. M. Cohen, J. E. Burns, and R. Sear. Acta radiol. **53:** 401–413, May 1960; 486–504, June 1960. (London Hospital, Whitechapel, London, England)

In the first part of this article on the physical aspects of cobalt-60 teletherapy with wedge filters, the authors describe wedge filters for use with a Picker C 3,000 cobalt unit. Measurements were made of build-up, transverse field distributions, percentage depth doses, isodose curves, and absolute dose rates. It is shown that the presence of a wedge filter does not appreciably alter the build-up characteristics of the radiation. For a given wedge (*i.e.*, a given field width), a single isodose chart suffices for all field lengths, within limits of ±5 per cent.

Eight figures; 2 tables.

In the second installment the authors discuss in detail the addition of two wedge fields for cobalt-60 gamma rays, using the analytical approach of Cohen (Acta radiol. **52:** 158, 1959. Abst. in Radiology **75:** 333, 1960) and Sear (Phys. Med. & Biol. **4:** 10, 1959). Examples of combined field isodose charts are given. Dosage tables permit a choice of 25 two-field arrangements for each wedge. A wax compensating wedge, individually molded for each patient, takes into consideration the fact that the body surface is usually neither flat nor normal to the beam. The principle and experimental basis of the method are described.

Ten figures; 3 tables.

Induction of Neoplasms in Rat Thyroid Glands by Low Doses of Radioiodine. G. D. Potter, S. Lindsay, and I. L. Chaikoff. Arch. Path. **69:** 257–269, March 1960. (University of California, School of Medicine, Berkeley, Calif.)

In studies reported earlier (Cancer Research **17:** 183, 1957) the authors found the highest incidence of radiation-induced tumors of the thyroid in rats that had received 10 μc or 25 μc of I^{131}. In some of the rats given larger doses, the thyroid glands were completely destroyed; in those with residual thyroid tissue, the incidence of radiation-induced thyroid neoplasms was reduced, and the growth of naturally occurring thyroid tumors was inhibited. The authors now report studies in which single as well as repeated low doses of I^{131} were administered, with attention directed particularly to the pathogenesis of the tumors induced.

Two hundred eight-week-old Long-Evans rats were

divided into two groups. Each rat in one group received a single intraperitoneal injection of 25 μc of carrier-free I^{131}, while each rat in the second group was given a total of four intraperitoneal injections of 10 μc of carrier-free I^{131} at one-month intervals. Two years after the initial injection, 23 of the 100 rats given 25 μc of I^{131} and 28 of the 100 rats that had received 40 μc survived.

Approximately one-third of the irradiated thyroid glands were of normal size, with symmetrical lobes; another third displayed diffuse enlargement of either one or both lobes, but with smooth, non-nodular surfaces; the remaining third showed diffuse or nodular enlargement of one or both lobes, with lobulated surfaces. Papillary and follicular carcinomas were found in the thyroid glands of 12 of the I^{131}-injected rats. All but 2 of the rats had benign thyroid nodules or adenomas; 3 of these adenomas were of the papillary type. Naturally occurring alveolar or lobular carcinomas were found in approximately one-third of the animals.

A high incidence of hyperplastic and neoplastic parathyroid lesions was observed in the rats receiving I^{131}, but these lesions are not considered to be the effects of irradiation.

Eighteen figures; 1 table.

Radioautography of the Conduction System of the Dog's Heart with I^{131}. Herman N. Uhley, Stanley B. Reich, and Laurence Rivkin. Am. J. Physiol. **198:** 859–860, April 1960. (Mount Zion Hospital, San Francisco, Calif.)

The conduction system of most mammalian hearts is difficult to visualize. The authors investigated the possibility that the application of I^{131} in minute quantities to the endocardium might result in the binding of a minimum of elemental radioactive iodine to the glycogen contained in the conduction system, but still suffice for its detection therein. The study showed that the conduction system of the dog heart has a distinct affinity for superficially applied radioactive iodine. The glycogen content of this tissue and the latter's relatively close proximity to the endocardial surface probably account for this reception and retention of elemental iodine. Radioautographs of the ventricular conduction system were obtained.

The relatively minute amount of radioiodine needed for the identification of the intact conduction system poses the possibility of its employment in cardiac surgery. It is conceivable that suitable radioactive compounds in small concentrations will be harmless but will permit identification of the conduction system during cardiac surgery with a monitoring device.

Two photographs; 1 radioautograph.

Placental Transfer of Phosphorus in Sows Maintained on High and Low Levels of Dietary Manganese. H. W. Newland, G. K. Davis, and H. D. Wallace. Am. J. Physiol. **198:** 745–748, April 1960. (H. W. N., Michigan State University, East Lansing, Mich.)

Placental transfer of phosphorus was studied in 16 young sows which had been maintained on high and low levels of dietary manganese during their first gestation. Radiophosphorus absorption and the concentration of total phosphorus were found to be directly related to the weight of the fetus. Also, the absorption of P^{32} and the concentration of phosphorus was essentially the same in fetuses from sows on different levels of dietary manganese. Fetal femurs metabolized P^{32} more rapidly than did maternal femurs, fetal hearts and fetal livers, while maternal livers showed more activity than any other maternal or fetal organ. Small fetuses at the sixtieth and eightieth day of gestation had a higher specific activity than larger fetuses of the same age. Radiophosphorus placental transfer rate increased steadily during the last half of pregnancy.

One graph; 4 tables. AUTHORS' ABSTRACT

Rate of Loss of Radioiron from Mouse and Man. John D. Bonnet, Alan L. Orvis, Albert B. Hagedorn, and Charles A. Owen, Jr. Am. J. Physiol. **198:** 784–786, April 1960. (Mayo Clinic, Rochester, Minn.)

Forty-two male and female mice, eight weeks old, were given radioiron (Fe^{59}) in doses of 0.006-0.1 μc, containing 0.013–0.17 μgm. of iron, by intraperitoneal or intravenous routes. Assays of the radioactivity of the whole body revealed an initial rapid loss of Fe^{59} (15 to 20 per cent) lasting about six days. Thereafter the Fe^{59} left the mice at a steady rate of 0.39 per cent/day (half-life one hundred and eighty days).

One 34-year-old normal man was given 10.6 μc of Fe^{59}, containing 8.2 μgm. of iron, intravenously. Based on counts from the entire body, the biologic rate of loss of the Fe^{59} was about 0.14 per cent/day (half-life five hundred days), and there was little or no initial loss such as occurred in the mouse. The Fe^{59} in the circulating erythrocytes was essentially unchanged for the first three months. It then fell to a new level of about 90 per cent of the previous value; the mid-point of the fall was about one hundred and twenty days after the administration of the radioiron. The difference in the rates of loss of radioiron from mice and man seems to be related primarily to the life span of the circulating red cells.

Three figures. AUTHORS' ABSTRACT

Renal Excretion of Radiofluoride in the Dog. Curtis H. Carlson, W. D. Armstrong, Leon Singer, and Lerner B. Hinshaw. Am. J. Physiol. **198:** 829–832, April 1960. (University of Minnesota Medical School, Minneapolis 14, Minn.)

Renal clearances of continuously infused radiofluoride were measured in 10 dogs in which a large part of the skeleton had been excluded from the system in order to produce a more constant plasma radiofluoride concentration. The results were evaluated to describe the factors of glomerular filtration and tubular reabsorption of fluoride under several conditions. The animals that received carrier-free radiofluoride infusions excreted urine with a mean radiofluoride concentration 3.4 to 14.5 times that of the plasma. The urine-to-plasma concentration ratios obtained with animals given a load of stable fluoride was 13.5 to 29.6. An increased urine volume resulted in a decreased tubular reabsorption of fluoride and the clearance was increased. Chlorothiazide increased radiofluoride excretion but decreased the urine concentration. The radiofluoride clearances were always less than the creatinine clearances but were 7.8 to 179 times the chloride clearances. The effect of chlorothiazide was to decrease the ratio of fluoride to chloride clearance by increasing chloride clearance more than fluoride clearance.

Two figures; 2 tables. AUTHORS' ABSTRACT

Investigations on the Strontium-90 Content of Fodder and Milk. Ekkehard Groos. Strahlentherapie 110: 66–69, September 1959. (In German)(Max Planck Institut für Biophysik, Frankfurt Main, Germany)

The strontium-90 content of milk from a cow was determined at regular intervals and the variations observed were recorded. The cow was fed, according to general custom, with hay in the winter and with green grass in the summer. Except for an unexplained rise in February 1958, the dry feeding period was marked by the lowest values (between 2.5 and 5.4 units), whereas the grass-feeding period was characterized by values up to 14.3 units. The milk samples were large, as they were collected over a period of ten to fourteen days.

Samples of the food were also tested. Hay had a low value of 33, whereas grass showed an activity up to 500.

One table.

GERHART S. SCHWARZ, M.D.
New York, N.Y.

RADIATION EFFECTS

Radiation Hazards in X-Ray Diagnosis. F. M. Hooper. M. J. Australia 1: 572–576, April 9, 1960. (Royal Alexandra Hospital for Children, Sydney, N. S. W., Australia)

The author discusses two problems: How real and how serious are roentgen hazards and what precautions should be taken.

Most of our information on radiation risks comes from work on the mouse and the fruit fly and it is uncertain how far we can transfer findings from these species to man. In many experiments in which a whole population has been given doses of 100 r or more, and followed for many generations, skillful technic is required to show that even individuals have been harmed.

Of the various estimates of risk, the greatest should be chosen in designing protection for workers in industry and the best possible protection should be given. In diagnostic radiology, however, overestimation of the risk will often lead to denying the patient a valuable procedure.

Protection measures mentioned are: (1) better cooperation between clinician and radiologist; (2) fewer films per patient; (3) limitation of the area irradiated by employment of small cones, rectangular cones, light beam diaphragms, lead rubber angle plates, lead shields; (4) less use of fluoroscopy; (5) technics that reduce the dose of x-rays. It is important that the equipment should be in good order; in particular, there must be no faults in the lead shielding about the x-ray tube.

The author concludes that diagnostic roentgen hazards are small and will be smaller still when everyone makes the best use of protective measures. The greatest risks in x-ray diagnosis are and always have been incomplete examinations and inaccurate interpretation.

One table.

Carcinoma of the Thyroid Gland in Childhood: Its Relation to Radiotherapy. Russell Howard. Australian & New Zealand J. Surg. **29:** 329–331, May 1960. (Royal Children's Hospital, Melbourne, Australia)

The author has treated 3 cases of thyroid carcinoma in children, all of whom had irradiation to the neck during the first week of life. The diagnosis was established at the ages of twelve, fourteen, and eleven years, respectively. In the first 2 cases, lumps in the neck were known to have been present from the age of ten; the tumors were of the papillary adenocarcinoma type and were reported by Webster and Howard (Australian & New Zealand J. Surg. **24:** 1, 1954), who did not appreciate at the time the facts regarding the early irradiation.

The third case is now recorded, in an eleven-year-old girl. A total dose of 2,400 r had been given to a cutaneous hemangioma in the region of the chin, commencing shortly after birth and continuing over the first year of life. At surgery, in 1958, a malignant mass was found, of such an extent that removal of the entire tumor was impossible. Subsequent treatment included irradiation with the cobalt bomb and the administration of thyroid extract. On this regime the child had continued well up to the time of this report (eight months after surgery).

The amount of radiation necessary to produce cancer in children does not need to be large. The lowest recorded activating dose is 160 r (Wilson *et al.* Brit. M. J. **2:** 929, 1958. Abst. in Radiology **73:** 325, 1959). Clark (J.A.M.A. **159:** 1007, 1955. Abst. in Radiology **67:** 477, 1956) stated that in each of the 15 cases which he reported, 200 r or more had been given, whereas in 1,722 cases with less dosage cancer failed to develop. The latent interval between irradiation and development of carcinoma is variable and seems to have no relation to the roentgen dosage.

It would seem (1) that the relationship of irradiation of the thyroid during the early years of life to the subsequent development of cancer is definite; (2) that the cells of the adult thyroid do not exhibit the same tendency to cancer development in response to roentgen stimulus as do the cells of children.

Two photomicrographs.

Radiation Necrosis of the Ossicles. Joseph Gyorkey and Frederic J. Pollock. Arch. Otolaryng. **71:** 793–796, May 1960. (Illinois Eye and Ear Infirmary, Chicago, Ill.)

Destruction of the incus due to massive irradiation has never been recorded, perhaps because extensive radiotherapy is usually given for malignant neoplasms and the patients do not survive long enough for such destructive changes to develop. The authors report a case of radiation necrosis of the ossicles.

The patient was first seen in 1951, at the age of eleven years, when he was suffering from severe headaches, vomiting, sudden vertigo on change of position of the head, neck rigidity, and visual disturbances. Following the ventriculographic demonstration of a mass rising from the floor of the fourth ventricle, an occipital craniectomy was performed and almost all of the tumor was removed. Histologic examination showed it to be an ependymoblastoma. X-ray therapy was administered for a total dose of 9,900 r; the tumor dose was approximately 4,251 r.

Two years later (1953) the patient began to complain of hearing loss in the right ear. The difficulty progressed, and in 1958 examination revealed a marked air-bone gap and fairly good bone conduction up to 4,000 cycles. It was reasoned that a fixation of the stapes

could account for the hearing loss. Exploration disclosed replacement of the long process and lenticular process of the incus by a loose fibrous band, which joined the head of the stapes. This was thought to be the end-result of an aseptic necrosis due to the effect of irradiation on the vascular supply of the long process of the incus. Hearing was restored to a useful level in the speech frequencies by a myringostapediopexy.

Four audiograms.

Effect of Repeated Fluoroscopic Examinations on 1480 Children with a Long-Term Follow-up Study. Ann McA. Birch and David H. Baker. New England J. Med. **262:** 1004–1008, May 19, 1960. (New York Hospital, New York, N. Y.)

The authors attempt to determine the effects of ionizing radiation, if any, in serial fluoroscopic examinations, over a long period, in patients attending the Rheumatic Cardiac Clinic at the New York Hospital. A detailed study of the incidence of all types of neoplastic disease and congenital anomalies in the patients' progeny forms the basis of this report. The records of 746 female and 734 male patients were selected, using the following criteria: all patients had at least three fluoroscopic examinations, all were followed for at least three years after the year of their first fluoroscopy, and all were followed after 1932.

Fluoroscopy in all cases was performed by nonradiologists with widely varying experience. The whole thorax was examined in most cases, with frequent student demonstrations, so that the patients as a group received a heavy exposure. Fluoroscopy was done in three projections (anteroposterior, left oblique anterior, and right oblique anterior) to determine the size of the heart chambers and to check particularly for any changes since the previous examination. It was estimated that the average output for the fluoroscope employed between 1921 and 1932 was 20 r per minute. Also, during this period x-ray cardiograms were taken repeatedly, using orthodiagraphy. After 1932, a vertical fluoroscope with an output of 10 r per minute at the table top was employed. In the tabulation, each fluoroscopic examination with the old machine was counted as two because of the higher output. The number of fluoroscopies for each patient ranged from 3 to 128. Only 1 patient had more than 100; 37 had more than 50. The mean number of fluoroscopies was 18 per female patient and 17 per male patient.

One carcinoma of the breast and one generalized lymphosarcoma occurred among the 746 female patients; no malignant tumors developed among the 734 males. No case of leukemia was encountered. There were 8 cases of nonmalignant thyroid disease and 5 fibroadenomas of the breast.

One hundred and twenty-one women received fluoroscopic examinations during pregnancy. Dead fetuses were delivered in 6 (4.9 per cent). Six hundred and thirty-five live births and 16 stillbirths occurred to female patients, for a stillbirth rate of 2.5 per cent of total births. Four hundred and twenty-seven live infants and 9 dead fetuses were born to wives of male patients, a rate of 2.1 per cent. None of the sample rates differ significantly from the New York State rate of 2.1 per cent.

There were 14 babies with congenital abnormalities born to female patients, and 7 to wives of male patients. Twelve (29 per cent) of the parents in 41 patient pregnancies, producing 12 stillborn or congenitally defective babies, had possible or proved congenital heart disease. This suggests the role of hereditary factors. Of the 16 stillbirths to mothers who were patients, 6 were due to obstetric or maternal conditions: 2 to eclampsia, 2 to erythroblastosis fetalis, 1 to hemorrhage; 1 stillborn infant was born to a mother with habitual abortions. Of the 9 stillbirths to wives of male patients, 3 could be attributed to obstetric conditions. Two were associated with severe anomalies, both of the same father. The parents of the abnormal children had the same number of fluoroscopies as did the parents of normal children. The rate of congenital anomalies was similar to that reported in the literature for the general population.

The authors stress that the absence of observed deleterious effect in a group this size should not be construed to mean that fluoroscopy entails no risk.

Four tables.

JOHN A. CAMPBELL, M.D.
Indiana University Medical Center

Effects of Protracted Irradiation on the Blood-Forming Organs of the Rat. Part I: Continuous Exposure. L. F. Lamerton, A. H. Pontifex, N. M. Blackett, and Kay Adams. Brit. J. Radiol. **33:** 287–301, May 1960. (Royal Cancer Hospital, London, S. W. 3, England)

Changes in the blood and bone marrow were studied in rats subjected to continuous total-body irradiation from a cesium-137 source at dose rates ranging from 16 to 415 rads per day. Each animal was irradiated continuously at the dose level chosen until death occurred or, at the lower dose rates, until accumulated exposure values reached as high as 10,000 rads. Survival data, exposure data, weight changes, and many determinations of blood values (hemoglobin, platelets, mononuclear leukocytes, and polymorphonuclears) are presented in graphs and tables in considerable detail. In addition, a number of bone-marrow biopsies were obtained from the femurs.

Between 84 and 50 rads per day, there is a very substantial increase in animal survival time and in the total dose that may be accumulated prior to death. It was observed that the total radiation doses accumulated before death under continuous irradiation are far greater than the mean lethal dose (thirty days) of 500 to 600 rads for these rats when the exposure is given in a period of a few minutes.

From the great mass of information reported, the following facts appear particularly pertinent. At dose rates of 84 rads/day and below, there is a recovery in platelets and white cells after an initial fall. This recovery commences at about twenty days after irradiation is begun and at 84 rads/day is only transient. At 50 rads/day and below, however, near-normal levels of blood count are maintained for a long period of time, despite continuing irradiation. The cause of death of animals receiving protracted irradiation, at dose rates of 415, 176, and 84 rads/day, was in nearly all cases hematopoietic failure. Death in most instances was preceded by a sudden terminal anemia, apparently the result of severe hemorrhage. Splenectomy profoundly affects the pattern of change, particularly with respect to the platelet level and the level of mononuclear leukocytes. So far as the mononuclears are concerned, the results with splenectomized animals indicate that mobilization and regeneration result mainly from the action of the spleen.

There is evidence in the present investigation of marked differences in the response to continuous irra-

diation of the various cell types in the blood, with the megakaryocyte-platelet system being probably the most vulnerable.

Possible mechanisms for the maintenance of a "steady state" of the cell population of the blood-forming organs under continuous irradiation are discussed in relation to similar findings in the response of the intestinal epithelium.

Twelve graphs; 3 tables.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Bioelectric Responses in Situ of Mammalian Nerves Exposed to X-Rays. C. S. Bachofer and M. E. Gautereaux. Am. J. Physiol. **198:** 715–717, April 1960. (University of Notre Dame, South Bend, Ind.)

X-irradiation of ventral caudal nerves of the rat *in vitro* produces an increase in spike amplitude and in conduction velocity of the propagated impulse. The nerves were irradiated until they ceased to respond to stimulation. In order to determine to what extent the results were due to the artificial environment in which the nerve was placed, a series of experiments was carried out in which the bioelectrical effects of x-rays on the ventral caudal nerve *in situ* were investigated. Immediately upon irradiation there was a considerable increase in spike amplitude and a somewhat lesser increase in conduction velocity. Following the increase, there was a deterioration with ultimate block of conduction. At equal doses the *in situ* preparations were slightly more radiosensitive.

There was a remarkable similarity in the responses of nerves irradiated *in vitro* and *in situ*. The effect cannot be attributed to such environmental factors as a change in temperature of the preparation or to alterations in the blood supply. It is apparently due to an altered condition of the nerve fiber itself, since the x-rays do not act synergistically to produce the enhancement here reported.

One graph.

Changes in Membrane Potentials, K Content, and Fiber Structure in Irradiated Frog Sartorius Muscle. Edgar B. Darden, Jr. Am. J. Physiol. **198:** 709–714, April 1960. (Biology Division, Oak Ridge National Laboratory, Oak Ridge, Tenn.)

Changes in membrane potential, K content, and fiber structure were studied in excised frog sartorius muscles that had received massive single doses (50–200 kr) of x-radiation. With muscle in normal Ringer's solution at 25° C., the median membrane potential declined and K leakage increased progressively, as measured at intervals, after exposure doses above ~100 kr; in K-rich Ringer's solution, decline was appreciably slower. In individual irradiated fibers, membrane potentials recorded at different points along a fiber tended to be nonuniform. When subsequent histologic alteration occurred, it often originated as a focal disorganization of structure in a region of minimum membrane potential. Visible pathologic changes resembled in part Zenker degeneration in intact muscle. It is suggested that decline in membrane potential, histologic changes, and increased K leakage are different expressions of the same basic radiation lesion. Radiation-induced changes were markedly retarded by posttreatment storage at 3° C.

Six figures; 1 table. AUTHOR'S SUMMARY

Species Differences in Altitude Tolerance Following X-Irradiation. Bernard D. Newsom and Donald J. Kimeldorf. Am. J. Physiol. **198:** 762–764, April 1960. (U.S. Naval Radiological Defense Laboratory, San Francisco, Calif.)

The relationship between altitude tolerance and food consumption was investigated in irradiated and nonirradiated animals of several species. Food consumption was measured for three days following a mid-lethal dose of x-irradiation to assess the degree of postirradiation anorexia. Seventy-two hours after irradiation these animals, as well as *ad libitum*-fed and food-deprived animals, were exposed to a simulated altitude tolerance test. The mortality produced in four hours was used as the criterion of hypoxic tolerance for each species. Irradiated rabbits and rats exhibited a severe decrease in food consumption and an increased hypoxic tolerance. Food consumption of mice was depressed during the three days following irradiation, although the effect was much less than that observed for rats and rabbits. Guinea-pigs and hamsters showed only a slight decrease in food consumption with recovery occurring after twenty-four hours. Mice, guinea-pigs, and hamsters did not exhibit a significant increase in hypoxic tolerance three days after radiation exposure. When nonirradiated rabbits, rats, mice, and guinea-pigs were deprived of food, the hypoxic tolerance was significantly increased in all species.

Two figures.

Biologic Protection Against Repeated Lethal Total-Body Exposure Doses. Hanns Langendorff, Hans-Joachim Melching, and Hans-Adolf Ladner. Strahlentherapie **110:** 34–40, September 1959. (In German) (Radiologische Institut der Universität Freiburg/Br., Germany)

This is the 32d of a series of communications on biological radiation protection appearing in this journal under the general heading "Investigations of Biological Protection Against Radiation." It deals with the protective effect of 5-hydroxytryptamine (Serotonin). The main interest of the investigators centered in the question whether or not this substance would lose its effectiveness after repeated use. For this reason repeated exposures had to be delivered to male and female white mice. The animals were divided into groups, each of which received three equal exposures in sixty days. The doses were thus 500 r × 3, 590 r × 3, etc., up to 1,100 r × 3.

An intraperitoneal injection of 1 mg. of the protective substance was given five minutes prior to each exposure. Survival curves were then entered on graph sheets and evaluated by the probit-analysis method of Finney. This permitted the investigators to arrive at a "dose-reduction factor" by comparing the survival of unprotected controls with that of the injected animals. This dose-reduction factor was found to be as follows: In female animals: after the first irradiation, 1.99; after the second irradiation, 2.07; after the third irradiation, 1.82. In male animals: after the first irradiation, 1.87; after the second irradiation, 2.12; after the third irradiation, 1.93.

Of interest was the fact that after ninety days some mice were alive even in the group subjected to the heaviest irradiation (3,300 r total). The authors conclude that Serotonin does not seem to lose its protective powers after repeated administration but raise the question whether the repetition of the radiation ex-

posure itself might not perhaps induce radiation resistance. If that were so, the above conclusion would be invalidated.

Two graphs; 3 tables.

GERHART S. SCHWARZ, M.D.
New York, N. Y.

The Relative Biological Efficiency of 20 MV and 4 MV Radiations. A Report from the Medical Research Council Group, Christie Hospital, Manchester 20 (England). I. Introduction. Ralston Paterson. Brit. J. Radiol. **33:** 271–272, May 1960. **II. Physical Aspects.** David Greene and John B. Massey. Ibid. pp. 272–274. **III. The Oxidation of Ferrous Sulphate Solution.** W. M. Dale, J. V. Davies, D. Greene, and J. P. Keene. Ibid. pp. 275–277. **IV. Experiments on the Survival of *E. coli B*.** W. M. Dale and C. Russell. Ibid. pp. 277–278. **V. Induction of Dominant Lethal Mutations in Drosophila Sperm.** A. J. Bateman. Ibid. pp. 278–280. **VI. Experiments on Organ Weight Loss and 50 Per Cent Mortality in Mice.** Edith Paterson and D. D. Porteous. Ibid. pp. 280–284. **VII. General Review.** Ralston Paterson. Ibid. pp. 284–286.

In 1957, a series of studies was published from the Christie Hospital, comparing 300 kv with 4 Mv radiation from the linear accelerator. (Brit. J. Radiol. **30:** 337–355, 1957). A report is now made of an attempt to compare the relative biological efficiency of 20 Mv radiations (betatron) with 4 Mv radiations (linear accelerator), using the 4 Mv values as unity. The investigators give in short papers the results of megavoltage irradiation of several commonly employed biologic specimens and the inorganic substance, ferrous sulfate, in solution. The contributions in general are technical and give careful descriptions of the manner in which the experiments were performed, the technical and theoretic difficulties encountered, and a summary of the mathematical results obtained. Those biologic materials specifically investigated included *Drosophila*, mice (mortality and weight changes in thymus and testes), and *E. coli* cultures. To a lesser extent comment is made, and clinical impressions given, concerning skin tolerance and general tolerance of patients to the two types of radiation.

The moderator of the Symposium, Professor Paterson, summarizes the data obtained by the various investigators and comments on their significance. Values from the current series of experiments are then compared with those from previous studies, relating the relative biologic efficiency of conventional 300 kv radiations to 4 Mv beams. The figures for all the biologic materials, without exception, are to a greater or lesser degree below unity (4 Mv). It is therefore a reasonable assumption that the 20-Mv radiation has a lower radiobiological efficiency value. The evidence seems to suggest, however, that the lowering of relative biologic efficiency as we move from 4 to 20 Mv is distinctly less than the lowering between 300 kv and 4 Mv. This is in agreement with the clinical impression.

Professor Paterson suggests that for clinical purposes one RBE value be taken for the whole megavoltage range, from cobalt through to at least 20 millions compared to conventional deep therapy. This value lies between 80 and 90. For work at the Christie Hospital, he proposes to use 100 to 85 as a single factor to cover cobalt, 4 Mv, and betatron radiations.

A brief table of the scale of RBE values then reads as follows:

300 kv therapy—100
500 kv therapy—about 95
3 Mv cobalt beam—? (somewhere between 85 to 90)
4 Mv linear accelerator—85
20 Mv betatron—81

Tests with the various biologic materials showed short ranges of overlap from one radiation quality to the next.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Comparative Effects of Prenatal Gamma Radiation and X-Irradiation on the Reproductive System of the Rat. Benjamin H. Ershoff and Ved Brat. Am. J. Physiol. **198:** 1119–1122, May 1960. (Western Biological Laboratories, Culver City, Calif.)

Experiments were undertaken to determine the comparative effects of prenatal roentgen and gamma (Cs^{137}) irradiation on the development and morphology of the reproductive system of the young rat. A sex difference in the response was found. The male offspring of rats exposed to either 300 r x-irradiation (administered as a single dose at the rate of 17.92 r/min.) on the eighteenth day of pregnancy or to 300 r gamma irradiation administered continuously from the thirteenth to the twentieth day of pregnancy (at a dose rate slightly less than 0.03 r/min.) exhibited a significant degree of gonadal injury. In female offspring, the ovaries were of normal size and appearance in rats whose mothers were given x-irradiation, but were significantly reduced in size and contained neither follicles nor corpora lutea when the mother rats received gamma irradiation.

Nine photomicrographs; 1 table.

AUTHORS' ABSTRACT

The Testing of Indoleamine Compounds in the Prevention of Radiation Illness. L. F. Semenov. M. Radiol., Moscow **5:** 47–51, May 1960. (In Russian) (Institute of Experimental Pathology and Therapy, Sukhumi, U.S.S.R.)

Determinations were made of survival rates of mice which had received certain indoleamine compounds alone and combined with acetylcholine, prior to irradiation in lethal dosage (700 r of roentgen rays or 1,050 r of gamma rays). Serotonin with acetylcholine gave 70 per cent survival; tryptamine with acetylcholine 64 per cent; tryptamine alone 12 per cent, and Serotonin 23 to 28 per cent. Less protection was afforded by beta-mercaptoethylamine or Adrenalin with acetylcholine. It is thought that a peripheral neurotropic action accounts for the protective effect of the indolethylamides.

FRANK A. RIEBEL, M.D.
Columbus, Ohio

March 196

0 million cou
This value lies
ristie Hospital,
factor to cover

s then results in

ween 85 to 90)

ls showed short
lity to the next.
ARBER, M.D.
eyenne, Wyo.

mma Radiation
System of the
Brat. Am. J.
(Western Bio-
)

determine the
en and gamma
nd morphology
ng rat. A sin
The male off-
r x-irradiation
ate of 17.92 r/
ncy or to 308 r
uously from the
nancy (at a dose
ibited a signifi-
male offspring,
appearance in
ation, but were
ntained neither
nother rats re

RS' ABSTRACT

nds in the Pro-
Semenov. M.
. (In Russian)
and Therapy,

al rates of mice
ine compounds
prior to irradia-
rays or 1,000 r
lcholine gave 70
ylcholine 64 per
Serotonin 25 to
orded by botu-
h acetylcholine,
ropic action on
ndolethylamides.
RIEBEL, M.D.
olumbus, Ohio